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J. W. POWELL DIRECTOR

CONTRIBUTIONS

TO THE KNOWLEDGE OF THE

OLDER MESOZOIC FLORA OF VIRGINIA

By WILLIAM MORRIS FONTAINE

WASHINGTON
GOVERNMENT PRINTING OFFICE
1883

UNIVERSITY OF VIRGINIA, VA.,
August 20, 1882.

SIR: I herewith transmit the manuscript and plates of my memoir on "The Older Mesozoic Flora of Virginia."

The work is based upon the study of a number of plants obtained after several years of diligent search in the older Mesozoic strata of Virginia. The many difficulties attending the collection of fossils from these beds show that the plants here described form but a small fragment of what was evidently a rich flora. Still the list is sufficient, I think, to give us a fair idea of its general character.

I am, with respect, your obedient servant,

WM. M. FONTAINE.

Hon. J. W. POWELL,
Director United States Geological Survey.

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THE OLDER MESOZOIC FLORA OF VIRGINIA.

BY WILLIAM M. FONTAINE.

PART I.

THE GEOLOGY OF THE MESOZOIC AREAS.

The occurrence of the plants forming the flora of the older Mesozoic beds of Virginia cannot be made intelligible without some account of the strata that contain them. I shall give of the geology of the several Mesozoic areas only so much as will be necessary to show the characteristics of the occurrence of the fossil plants found in them.

The Mesozoic beds of Virginia are all situated east of the Blue Ridge, and most of them are found within the terrane of the crystalline Azoic rocks. They lie on the eroded and upturned Azoic strata, and are formed out of the material yielded by them. Two series of Mesozoic beds must be distinguished from each other.

The older Mesozoic strata, those that contain the plants that form the subject of this memoir, although very variable, yet have many features in common that easily enable us to group them together. They now lie in long narrow strips isolated from each other, and seem to have been deposited in fresh, or at most, brackish water. Some of these areas were, at some period in their history, in the form of marshes, or had such a character as to permit the growth of an abundant vegetation and the accumulation of considerable amounts of coal. In Virginia coal is found only in those areas that lie farthest east.

The younger Mesozoic strata have very little in common with those just described, but by most geologists they have been grouped with them as forming a portion of the so-called Trias of Virginia.

This group of younger Mesozoic beds forms an interrupted and narrow belt, that extends north and south on the eastern margin of the Azoic rocks, outcropping between them and the Tertiary formation. The beds of this group show themselves, as a rule, only where the overlying Tertiary has been eroded away. In Virginia they are not known south of the city of Petersburg.

Numerous plants are to be found in them. These plants possess many interesting features, and show that the flora of this group is totally different from that of the older Mesozoic.

The areas occupied by the older Mesozoic beds, taken in order from east to west, have the following locations:

The most easterly of these is the one that may be named the Richmond Area, since its eastern edge passes about 10 miles west of Richmond. This is by far the most important area of Mesozoic in Virginia, since it contains nearly all the workable coal and yields nearly all of the plants found in the older Mesozoic. It forms an elliptical belt which has its longer axis directed a little east of north. For this reason to the north it is overlapped by the Tertiary formation, since this latter extends with its western edge almost due north and south. The length of the Richmond Area is about 30 miles, beginning at the south on the Appomattox River, and ending at the north in Caroline County, about 3 miles north of Hanover Junction. The average width is about 6 miles. This area shows a synclinal structure in the Mesozoic strata, the rocks on the east side dipping northwest and those on the west side dipping southeast. Coal has been worked on both sides of this area. The workings on the west side, however, are few and confined to the vicinity of James River. The openings for coal on the east side are more numerous and important. They are found on the extreme northern end, exclusive of the portion in Hanover, and extend, but with long intervals, to the extreme southern end.

That portion of this area that extends north of the Chickahominy River, lying mostly in Hanover County, contains no workable coal. This part, for the sake of distinction, may be called the Hanover Area. South of the Chickahominy, and extending for some distance north and south of James River, lies the main body of this Mesozoic area. As this contains all the workable coal, this portion may be called the Richmond Coal Field. It has afforded nearly all the plants described in this memoir. The following localities, mentioned in the description of the plants, are the most important sources of plant material, and are situated in this part of the area:

On the west side, near the village of Manakin, situated on the north bank of James River, occur the Dover Mines A deep shaft sunk here for the purpose of exploration, called the Aspinwall Shaft, has in the material taken out afforded some fine plants. Many more, no doubt, might have been obtained if I could have visited this shaft while it was being dug. I did not examine the material taken out until many years afterwards, and most of the impressions had been destroyed. It may be proper to state in this connection that the plants described in this memoir are by no means a measure of the richness of the flora of the beds yielding them. The work of collecting them has been attended with many difficulties. Since about 1840 almost no shafting has been done. The coal has been mainly followed by "inclines" from the outcrop, or raised through the old shafts; consequently, now, one must depend for collections chiefly on the old "dumps," and most of the material on these is thoroughly decomposed. In the early working of the coal in this field, as I learn from persons engaged in it, many fine specimens were obtained, most of which are now lost. Prof. William B. Rogers collected some of them, and gave some descriptions, and a few figures, that are referred to in my descriptions of the species. Sir Charles Lyell also obtained some that were described by Bunbury in the Quarterly Journal of the Geological Society. So far as I know, this is all that has been done in the way of figuring and describing these plants. Many of Professor Rogers's plants were not described, and I fear that the best portion of his collections has been lost.

Carbon Hill is another locality that has yielded me some good material. This is situated about six miles north of James River, on the eastern edge of the area. Here I was fortunate enough to find some material that had been taken out of a gangway cut to tap the lower coal bed. The roof shales of this bed are rich in plants, but owing to the mode of working the coal, which is confined mostly to the overlying bed, they are rarely reached.

Deep Run is another locality that has yielded plants. It lies about 3 miles east of Carbon Hill, in a small detached strip of coal-bearing strata. Midlothian, The Gowry, Black Heath, &c., are found some miles south of James River on the eastern border of the area. They yield some fine plants which, however, are collected with difficulty owing to the decomposed state of the material found on the old "dumps."

Clover Hill, at the southeastern end of the Richmond Coal Field, is the most important locality for the plants described in this memoir. Most of the impressions obtained by me, and the best preserved of them, came from this place. A tunnel was cut here recently to drain the water from one of the main shafts, and from this a large amount of sound rock was taken. Some of this shows good impressions of plants. Among these are the largest and most perfect specimens figured in this work.

The Hanover Area has yielded some plants, mostly, as it seems, from the same horizon as that of those from the Richmond Coal Field.

The Cumberland Area lies about 30 miles west of the Richmond Area. The longer axis of this, and of all of the areas yet to be mentioned, lies in a direction much more east of north than does that of the Richmond Area. In this case it runs about 25° east of north. This area begins on the south in Prince Edward County, and extends northeast for 22 miles, lying mainly in Cumberland County. Its southern end is much cut up by erosion, but north of the Appomatox River it forms a continuous belt with an average width of 1½ miles. This area, in all its geological features, is closely allied to the Richmond Area, and is in many features unlike the areas yet to be described, that lie farther west. It contains some coal that locally is workable, and yields some plants. The number of plants from this area might, no doubt, be largely increased were the strata exposed by working for coal. As it is, there is very little exposure of them, and almost no search has been made for the plants.

The Pittsylvania Area is a long and narrow belt, extending through Pittsylvania County to the southern border of the State. It is continued into North Carolina into the Dan River Coal Field. The longer axis of this belt runs about 40° east of north. Its length is 62 miles and average width 4½ miles. The average width varies little from the maximum, and is very uniformly maintained. It is then in form rather ribbon-shaped than elliptical. In its geological features it differs considerably from the two previously described areas, and is more like the Palisade Area presently to be mentioned. It has no coal beds, and has yielded no determinable plants. No doubt they exist, but no considerable search has been made for them. This is the most distant area from the Blue Ridge that shows any large amount of the deep red strata so characteristic of some of the so-called Trias of the eastern part of the United States. Here they form the lowest beds.

The Buckingham Area is a small oval patch, lying on James River, in the northern part of Buckingham County. It lies in the prolongation of the Palisade Area. It is about 18 miles long, with an average width of 4 miles. No coal exists, and no plants have been found. A very large proportion of the beds are coarse sandstones, conglomerates, and shales, mostly of a deep red color.

The Palisade Area is the largest area of older Mesozoic in the State. It forms a band, about 15 miles wide on the Potomac River where it enters the State, that extends 80 miles to the southwest, parallel with the Blue Ridge, and about 20 miles distant from it. This band narrows gradually to the south, and ends in Orange County. It is the continuation of the band of Mesozoic that begins at the Palisades on the Hudson River, and extends southwest through New Jersey, Pennsylvania, and Maryland. Its geological character in Virginia is similar to that found farther north. It enters Virginia between Point of Rocks, Maryland, and the mouth of Seneca Creek on the Potomac. It contains no coal, and no plants have been found, though search would probably reveal them. It is characterized by the large amount of red strata that it contains.

The determination of the details of the geology of these areas is very difficult. The exposures are few and very poor, owing to the ease with which the strata crumble to earth. The strata are exceedingly variable, and often the same bed, traced horizontally, changes to something very different in character. Nevertheless, certain broad features can be made out, and these only will be given here.

The more westerly areas, such as the Pittsylvania, Buckingham, and Palisade, contain no coal and possess a large proportion of red beds. The more easterly areas, the Cumberland and Richmond, contain coal and show little or no red beds. The amount of these red beds diminishes as we leave the vicinity of the Blue Ridge.

The Cumberland Area contains much more of them than the Richmond Area. In both of these the red strata, when found, occupy the lowest horizon. The strata of all the areas may be divided into three groups, and this division is most marked in the two coal-bearing areas. The coal in these occurs in the middle group, and is accompanied by a large proportion of black shales. The lowest beds of the two coal-bearing areas are sandstones and shales, of a predominant gray color, but with some red strata, which, however, in the Richmond Area are unimportant. The upper group, or series, is without workable coal in these two areas. It contains, however, in places, much lignite, which sometimes approaches jet in character. Some silicified wood is found on this horizon. In general, the upper strata of the Cumberland and Richmond Areas are loose granitic sandstones or sandy shales. The granitic sandstones often contain the ingredients of granite partly decomposed and unsorted. In some parts deposits of bowlders occur among the upper beds. The stones are sometimes many feet in diameter, and seem to have been transported from a distance. These bowlder deposits occur in all the areas, and on their western margins. The more western areas, the Buckingham, Pittsylvania, and Palisade regions, show also the threefold grouping of the strata, but in a less marked manner. Where plants and traces of coal occur in them they are found in the middle member. This member contains a comparatively small amount of red beds. The beds are here often gray, or greenish-gray. The lower group of these areas is usually characterized by the large amount of red strata present and the absence of traces of vegetable matter except silicified wood. The upper group or member varies in character with the locality, but it does not here (as in the coal-bearing areas) show the granitic grits that are so conspicuous in them. The beds are usually barren sandstones and shales, formed of well-sorted components.

The lowest group seems to correspond to a period of rather slow subsidence and slow accumulation of sediment. In the period of the formation of the middle member the conditions seem to have favored the growth of vegetation, perhaps because the subsidence was slower. The coal-bearing areas seem then to have been in the condition of a marsh. During the deposition of the upper group the sinking of the areas seems to have been more rapid, and the action of the water to have been sometimes quite violent if not aided by ice in some localities.

Owing to the extensive explorations for coal, the geology of the Richmond Area is much better known than that of any other. It is of much more importance, as this area gives us nearly all the older Mesozoic plants. It may also be taken as typical of the geology of the other areas. A few details will be given now of the geological structure of this field.

As stated before it has a synclinal structure, but many facts go to show that it did not possess this structure in its early history in such a marked manner as now. It, like the other areas, was a progressively subsiding region, probably, during most of the era of deposition.

The strata forming the lower group in the Richmond Coal Field are mostly sandstones, rather coarse in texture, and sandy shales. They are often much indurated and affected by "slickensides" and small local disturbances. The lowest sandstones are not easily distinguished from the underlying granitoid gneiss. The thickness of these beds varies much with the locality in which they occur. It ranges from less than 100 feet to 500 or 600 feet. These rocks are mainly of a gray color. The middle group varies in thickness from 100 to 200 feet. Here a large proportion of black shale occurs, some of which is very fine grained and so much indurated as to approach in nature a slate. Both these beds and the included coal show compression, local disturbances, "slickensides," &c., but in a less degree than the lower group. The number of the coal beds, their thickness, and their quality, vary in different parts of the field. Usually two independent and persistent seams are to be found. Sometimes for a short distance above and below these a number of smaller beds occur, but these seem to be local. They are found confined to a space of from 100 to 200 feet above or below the main beds. The lower persistent bed is found near the base of the middle group of the strata. South of James River it is from 4 to 5 feet thick, and is worth but little for fuel in comparison with the bed next above it. Hence its horizon is rarely reached. This is to be regretted, as its roof-shales have many fine plants. North of James River this lower bed becomes more important, apparently being there 6 to 8 feet thick. The interval between this and the next persistent seam above is pretty constant, being from 40 to 50 feet. This second persistent seam from the bottom is the main or big seam. This is always a double bed, usually separated by a sandstone and shale parting. Near the James, and north of it, the two members of this bed are of about equal thickness, and on the north of the river this thickness diminishes. Thus at the Dover Mines each member is about 6 feet thick. The interval between them here reaches its maximum in some places and shows the greatest amount of fluctuation in thickness. It is said to vary in no great distance from nothing to 40 feet. Perhaps this is due in part to the great disturbance that this part of the field has undergone. At Carbon Hill the interval is 17 feet and under, the lower member being 4½ and the upper 6 feet thick. In the southern part of the field the two members of this bed attain their maximum thickness, and this they seem to do at the expense of the overlying local beds. At Carbon Hill there is at least one bed 6 feet thick, 50 feet above the upper member of the main seam. This does not appear to exist at Midlothian. At this place Mr. O. Heinrich gives a full account of the coal beds. According to him the lower bed is 566 feet above the gneiss, and is composed of 3½ feet of coal and 1½ feet of shale. Omitting a small seam 12 inches thick, the next above is the main seam in two benches, the lowest 44 feet above the first coal bed. Between the two benches is a thickness of 10 feet of sandstone and shale. The lower bench is 12 feet thick, the upper one 14½ feet. Over this come 863 feet, as far as tested, of sandstones and shales, with no coal worth mentioning.

At Clover Hill, in the southeastern end of the field, the conditions are pretty much the same, except that some small coal seams occur above the main bed. The section of the coal beds at Clover Hill is as follows, beginning with the highest coal seam:

	Thickness.
15. Coal seam, local (?), 18 inches to	4 feet.
14. Interval, sandstone and shale	14 feet.
13. Coal seam, local	12 inches.
12. Interval, sandstone and shale	12 feet.
11. Coal seam, local	14 inches.
10. Interval, sandstone and shale	25 feet.
9. Coal seam, local	18 inches.
8. Interval, sandstone and shale	40 feet.
7. Upper bench of main coal	5 feet.
6. Interval, shale, varying in thickness	5 feet +.
5. Main coal, lower bench	15 to 26 feet.
4. Interval, sandstone and shale	40 feet.
3. Lower persistent coal bed	4 feet 9 inches.
2. Interval, sandstones and shales, about	250 feet.
1. Gneissic floor.	

The coal seam No. 15 may be a persistent bed. In that part of the field that lies north of James River there is a coal seam at nearly the same height above the main or big bed, and it is the bed that at Carbon Hill is partially coked by an overlying sheet of trap. This bed may exist at other localities and be overlooked, owing to its insignificance as a source of fuel. Its great variation in thickness at Clover Hill is due to the large amount of crushing that it has been subjected to. The thicker portions are caused by the concentration of the coal in them, it having been squeezed out of the thinner parts. This same action has, no doubt, caused the variation in the thickness of the lower bench in the main seam, viz., 15 to 26 feet. This coal bed No. 15 has a shale roof that is rich in plants, some of which are not found at any other horizon.

With the possible exception of this bed, the small seams occurring above the main seam at Clover Hill appear to be local.

Above No. 15 of this section there is at Clover Hill a considerable thickness of barren strata; perhaps 500 feet in all. Among these we find sandstones composed of granitic matter only partly sorted.

This brief account of the several Mesozoic areas may perhaps suffice to render intelligible the occurrence of the different species of plants.

PART II.

THE FOSSIL FLORA.

DESCRIPTION OF THE SPECIES.

EQUISETEÆ.

EQUISETUM, L.

Equisetum Rogersi, Schimper.

Plate I, Fig. 2; Plate II, Figs. 1 and 2.

Stem 6 to 9 centimeters thick, furrowed below the sheath for about 1½ centimeters, the rest of the internode smooth. Lower internodes shorter than the upper, with the length gradually increasing in ascending. Sheaths closely appressed, and 12 to 15 millimeters long. Teeth, 70 to 80 in number, about 8 millimeters long, ribbed, linear, and narrow to near the base, where they rapidly expand into the summit of the united leaves or ribs. Ribs, or united portions of sheath leaves, linear and separated from one another by a sharply-distinct keeled furrow, concave on the back, the concavity being embraced within two sharply-defined raised lines, which at the base of the rib lie at its outer margins, but gradually approach each other towards the summit of the same. At the summit of the rib they pass into the teeth and soon become approximately parallel, being almost in contact, forming the rib of the tooth.

The above-mentioned raised lines on the back of the ribs are the most characteristic feature in the sheath of this Equisetum. They begin, as stated, at the base of the rib, on its outer margins, and here the close proximity of the similarly-placed line on the adjoining rib determines a depression between the two ribs, whose cross-section is an acute angle, with its apex downwards. In ascending towards the summit of the rib the two lines approach each other, and depart more and more from the margin, so that the concavity of the back of the ribs, which is caused by the inward slope from these raised lines, and which is very slight near the base of the ribs, where they are far apart, becomes quite pronounced at the summit, where they approach each other closely. There is an outward slope also on the back of the ribs, away from these lines. At the summit of the ribs the angular depression measured from line to line is much broader than at their base. The grooves seen on the stem below the sheaths are caused by the gradual approach to each other of the raised lines, and when they meet the grooves terminate. The imprints of these grooves, seen in relief, appear as gradually tapering, sharply-defined, keeled ridges. Plate II, Fig. 1*a*, which represents a portion of the sheath magnified, shows these features. It will thus be seen that these lines determine the entire character of the ribs and teeth. They can very rarely be seen showing all the details that I have given here. I was fortunate enough to obtain at Clover Hill, in a fine-grained dark shale, specimens of the surface of the stem, and of its impressions on the shale, showing the smallest details with the nicety of a lithographic imprint. Plate II, Fig. 2, represents a portion of the stem in which the internodes are short, and on which the diaphragms do not appear. Plate II, Fig. 1, represents the largest specimen that I have seen on which the sheaths are displayed. On it the diaphragms show themselves. I have given 80 as the greatest number of teeth, as this is the largest number indicated on any impression seen by me. As the specimens represent stems which are pressed perfectly flat, I conclude that the number of ribs and teeth are at least twice as many as those seen on the surface exposed to view. Judging from the diameter of the casts of the interior of the stems, which sometimes occur perfectly cylindrical in shape, the thickness of the largest stems is about 8 to 9 centimeters. An average stem has a diameter of about 6 centimeters. On a stem of about this diameter, found at the Aspinwall Shaft near Manakin, four internodes exist, which give the following measurements: Lowest internode, 45 millimeters; second internode, 51 millimeters; third internode, 57 millimeters; fourth internode, 59 millimeters. This portion of the stem was evidently some distance from the base. It will be seen that the increase in length is quite gradual. The lower internodes are often so short that the furrows below the sheaths overlap the sheath of the internode below.

Plate I, Fig. 2, represents what is probably the rhizome of an Equisetum, and probably of *E. Rogersi*. The specimen is a fragment of a flattened stem, showing the epidermis which is finely striated and marked by rather large, prominent ribs which cross the diaphragms with no change of direction. No indications of a sheath are to be seen. As it is found with *E. Rogersi*, I consider it to be the rhizome of this plant.

This plant is one of the most characteristic fossils of the Richmond Coal Field, and has a wide vertical and horizontal range. I have found it in the Cumberland Area, and everywhere in the Richmond Area where plants occur. It is to be found in the highest strata of the Hanover Area which show fossil plants. It is noteworthy that it is almost everywhere found with *Macrotæniopteris magnifolia.* The association of the two is so constant that these plants would appear to have grown in close proximity to each other, for I do not think that this association could be explained by any similar peculiarity in their mode of preservation. Together with the Macrotæniopteris it often forms the only fossil of some localities. It is more commonly preserved in the form of a cast of the interior, known as Calamites, and described by several writers as *C. arenaceus.* I have seen no true Calamites in this coal-field; all the impressions appearing as such are casts of this Equisetum or of some Schizoneura. I was at one time strongly inclined to consider this plant identical with *Equisetum columnare*, which it resembles very closely. Prof. William B. Rogers, after a comparison of it with the figures given in Murchison's Memoir on the Brora Coal Field, was very positive in identifying it with the plant there described as *E. columnare.*

I have examined the figures accompanying this memoir, and do not think that they show enough characters to permit identification with our plant. The keeled ridges in the figures of Murchison's Memoir certainly strongly resemble those on *E. Rogersi.* I am now of the opinion that the Richmond plant is a distinct species, perhaps the representative of *E. columnare.* It should retain the name given it by Schimper, viz., *Equisetum Rogersi.* It does not seem to be identical with any of the figures of *E. columnare* which I have seen. Phillips, in the "Geology of Yorkshire," 3d edition, fig. 4, p. 197, gives a figure of *E. columnare*, which resembles what would be seen in our plant if the teeth were removed by maceration, and only the ribs with their converging raised lines were preserved. Our plant is quite different from *E. arenaceum* of the Keuper in the smaller size of the stems, the smaller dimensions of the sheath, and the lesser number of the teeth and ribs. The ribs also are not flat, do not narrow in the same way to form the teeth, and above all do not have any deciduous process at the end of the teeth. Bronn, in "Lethaea Geognostica," plate xii, fig 3, gives a representation of a plant from the "Lettenkohle" of the Keuper, which is very much like our plant. He calls this *Equisetites columnaris*, but Schimper argues, I think correctly, against the occurrence of *E. columnare* in the Keuper. At the same time this plant of Bronn seems to be quite different from *E. arenaceum*, as figured by all the authors, and especially by Heer, who has given excellent figures of this plant as found in the Keuper of Switzerland.

Perhaps Bronn's Equisetum may be the *E. mytharum* of Heer, which occurs in the Lettenkohle of Switzerland. At any rate this is the Triassic Equisetum that is nearest to our plant.

Schimper, in describing the plants from the Richmond Coal Field, has made the mistake of placing plants from the same strata in very different geological formations. Thus he places *E. Rogersi* in the lower "Marnes irisées" of Blackheath, near Richmond, Va., while he places its constant companion, *Macrotæniopteris magnifolia*, in the Oolitic strata of Richmond in Virginia. He places *Neuropteris linnææfolia*, also in the Oolitic beds of Richmond, although this plant, too, occurs in the same localities with *E. Rogersi*.

Formation and locality.—Everywhere in the Richmond Area, from the horizon of the coal beds to the highest beds of the area.

Equisetum arundiniforme, Rogers.

I have seen impressions of this plant as described by Prof. William B. Rogers in his paper on the "Age of the Coal Rocks of Eastern Virginia," published in the "Transactions of the Association of American Geologists and Naturalists." I am strongly inclined to think that they are casts of the young stems of *E. Rogersi*. There may be a second Equisetum in the Richmond Coal Field, as the internal casts called Calamites sometimes vary a good deal, but until an impression of the outer surface of a plant different from *E. Rogersi* is found, and while we do not know the limits of variation in the appearance of the casts of the interior of this plant, it would be unsafe to establish new species on the variations of such casts so far as as they have been seen.

Calamites arenaceus, Brongt.

These casts of the interior of *E. Rogersi* occur in immense numbers in the shales and sandstones between and immediately over the coal beds, and even in the coal itself. In the shales they are pressed perfectly flat. In the sandstones they are usually crushed more or less, but are not so flat as in the shales. Sometimes in the sandstones they retain their cylindrical shape perfectly. Sometimes in the roof of the main coal seam sandstone casts of Equisetum occur, which rise perpendicular to the top of the seam to a greater or less height. When the impressions are best preserved, as they are in the fine-grained dark shales, they appear as flat ribbon-shaped markings, often 10 to 12 centimeters wide, tapering gradually and marked at intervals by constrictions corresponding to the imprints of the diaphragms. Their surface is marked by fine, closely-placed parallel striæ, or ribs, which in passing across the constrictions are slightly bent out of their course.

Formation and locality.—Universally distributed at and above the horizon of the coal seams.

SCHIZONEURA, Schimp.

Schizoneura planicostata.

Plate I, Fig. 1.

Calamites planicostatus, Rogers.

The fossils which are supposed to belong here have the form of either flattened or cylindrical casts of the interior of the stem. Their character is as follows: Stem very large, diameter near the base, 17 centimeters and over, internodes of the middle portions of the stem, 17 centimeters long, as seen on flattened specimens; those of the lower part of the stem were seen only on cylindrical sandstone casts not well marked, but apparently are 7 to 9 centimeters long. Ribs 1 millimeter wide, and sometimes a little over, semi-cylindrical, prominent, closely placed, and striate.

The figure gives a representation of a large flattened cast, which is very perfectly preserved on a fine-grained shale.

The casts called *Calamites arenaceus* are marked by closely placed fine lines. Brongniart has given a good figure of one of them, which was sent to him from the Richmond Coal Field. It appears in the "Hist. des Vég. foss.," plate xvi, fig. 1, with the name *Calamites Suckowii*, var. δ. The plant now in question seems to have been far larger than *Equisetum Rogersi.*

I have found in the collections of the University of Virginia several specimens of this plant from an horizon not indicated. One of them is the sandstone cast of the interior of this plant, over 12 centimeters thick. Another cast is 17½ centimeters thick. The specimen figured is a small portion of a flattened cast in fine-grained shale, which is 15 centimeters wide, and shows an internode 17 centimeters long. The rounded ribs, the articulations of the leaves indicated by Professor Rogers, and the great size of the stem appear to indicate that this plant is a Schizoneura, but until the impression of the exterior of the stem is seen its true character cannot be positively determined.

Bunbury, in the third volume of the "Quarterly Journal of the Geological Society," under the head of *Calamites arenaceus*, says that some of the impressions called by that name are as much as 20 centimeters in diameter. He does not say whether this measurement is the width of a flattened stem, or the thickness of a cylindrical one. It is to be presumed that the latter is meant. These dimensions belong, not to *Equisetum Rogersi,* but to the supposed Schizoneura now in question, and it is probable that Bunbury had casts of this plant, on which the characteristic markings were not well shown. This occurs usually in the case of sandstone casts.

The cast depicted in fig. 1, on the parts where the coaly matter of the imprint is preserved, shows the characters above given quite distinctly. The original exterior of the casts, however, is very rarely preserved, for the prominent semi-cylindrical ribs are easily rubbed off, and leave in their place impressions looking like flat ribs. This feature is shown at *a* in the lower part of fig. 1. The ribs run across the nodes, usually suffering a slight deflection in their course, but sometimes they are interrupted, and abut against the interval between the ribs above. This, however, is rare. The space between two adjacent ribs appears to be rather rounded than angular at its bottom, and is shallow. This appears to be the plant named *Calamites planicostatus* by Professor Rogers. He seems to have noted it only in its condition after the removal of the raised ribs, for these almost never appear, while the flat markings are the most common and obvious features. Professor Rogers mentions seeing in the nodes small circular scars like the insertion of leaves, arranged at intervals of about half an inch. This fossil seems to be the cast of the interior of a plant very different from the *Equisetum Rogersi,* for the impressions called *Calamites arenaceus,* which are casts of the interior of this fossil, do not show any of the above characteristic features. If it is the cast of the interior of an Equisetum, it is certainly different from *E. Rogersi.*

Formation and locality.—It occurs not uncommonly in the strata under the main coal and above the bottom seam at Clover Hill, along with the casts of *E. Rogersi*, and also at Carbon Hill and other localities. From the material composing the large sandstone casts above mentioned, whose horizon and locality are not known, it would seem that it occurs also above the horizon of the coal beds. Poorly preserved specimens may readily be mistaken for *E. Rogersi* when in the form of casts.

Schizoneura. spec. ?

Plate I, Fig. 3.

This figure represents the flattened cast of the interior of some stem of which only a portion is preserved. As only one fragment was found, I can say nothing as to the size of the stem, of which the specimen is evidently only a small portion. The impression shows parallel, sharply defined, raised lines, which are semi-cylindrical, and narrow very slowly from a width of about half a millimeter in their most remote parts as they approach the nodes, where they are abruptly terminated in a blunt point, abutting against the interval between the adjacent pair of raised lines or ribs on the opposite side of the node. The impression seems to be that of the stem of a Schizoneura. The plant must have been very rare, as I found only one specimen.

Formation and locality.—Clover Hill, found in the strata accompanying the main seam.

Schizoneura Virginiensis, spec. nov.

Plate I, Figs. 4 to 6.

Stem 5 millimeters thick, smooth and finely striate; internodes 15 to 20 millimeters long; leaves, number not plainly indicated, probably as many as 24 and more, narrowly linear, 1 to 2½ millimeters wide, narrower at base, and slowly widening towards the middle, with fine nerves apparently 3 to 4 in number.

The leaves of this small plant are marked by delicate striations which look like slender nerves. The stem also appears striated by fine lines. The leaves of the lower nodes, as shown in Fig. 4, are depressed by crushing. Their natural position seems to be obliquely ascending, but in the very imperfect condition of the specimens this cannot be certainly established. Only two specimens of the plant have been found, and these are too imperfect to permit a full diagnosis or sure identification of the fossil to be made out. The leaves were evidently much longer than the parts which remain, and they seem to widen very slowly, being narrowed at base and summit. This plant has some resemblance to the Nematophyllum of the Upper Carboniferous of West Virginia and Southwestern Pennsylvania. In the description of Nematophyllum attention was drawn to its resemblance to *Schizoneura Meriani*, but the fact was overlooked that Schimper states that leaves of this plant had been seen united, showing that it is a true Schizoneura.

It is difficult to fix the relationship of this Schizoneura from so small an amount of material. It is clearly very similar both to *S. Meriani* of the Trias and to *S. hoerensis* of the Rhætic of Europe. Nathorst gives in his "Floran vid Högonäs" figures of *Schizoneura hoerensis* on plate i, figs. 1 to 4. Fig. 4 might be compared with our plant.

I do not, however, think that the specimens found indicate definitely the relationship of the plant in question, and in that case it is best to consider it, provisionally, as a new species. It might also be compared with *Schizoneura lateralis*, Schimp., (*Equisetum laterale*, Lind. and Hut.) of the Oölite of England. Schimper describes this as an Equisetum. Again, the branches and leaves which show the characters above mentioned may be parts of the plant which furnishes the large casts of the supposed Schizoneura previously described.

Formation and locality.—Found only at Clover Hill, in the strata associated with the main coal.

FILICES.

Macrotæniopteris, Schimper.

Macrotæniopteris magnifolia, (Rogers) Schimper.

Plate II, Fig. 3; Plate III, Figs. 1 to 3; Plate IV, Figs. 1 to 4; Plate V, Figs. 1 to 4.

Fronds simple, and those of the larger plants attaining the length of at least 1 meter and the width of 17 centimeters. Young fronds, according to stage of growth, varying in length from 5 to 40 centimeters and in width from 2½ to 5 centimeters and over. Outline of the adult fronds of two principal kinds, viz., oblong-spatulate and oblong-lanceolate; the first is bluntly rounded and broad at the end, and the second gradually narrowing with an elliptic extremity. Margins of the fronds thickened and having towards the summit a very regular sweep, but towards the base gradually approaching the midrib with a more or less undulate or irregular outline, and at the base closing in rather abruptly upon the midrib, the lamina on one side being usually more prolonged than on the other. Young plants in the early stages of growth are broadly elliptical in outline. The epidermis of the frond is usually thin except near the midrib, where it is so thick as to hide the insertion of the lateral nerves, and thus add to the apparent width of the midrib. Midrib of adult plants broad and flat, with comparatively few woody bundles, which appear as strong striæ on the surface of the midrib, tapering gradually to the summit; that of the younger plants, broad to about the middle of the frond, and then suddenly and greatly narrowed. Lateral nerves springing from the midrib under an acute angle, but immediately after their emergence becoming perpendicular to it, and thence continuing parallel to one an other and perpendicular to the margin of the frond, about one-half millimeter distant from each other, either not forking or forking close to the midrib, the branches very slowly diverging and soon becoming parallel to each other and to the adjoining nerves. In rare cases the nerves which are not forked in their lower portion branch at some distance from the midrib. The lateral nerves are apparently single nerves, but are really nerve-bundles, composed of two or three fine nerve-strands so consolidated as to appear, under ordinary conditions, as a single nerve.

Fructification not clearly made out, but apparently composed of elliptical sori, placed either in a single row on the midrib or in two rows, one on each side of the midrib.

This magnificent plant has been well described by Professor Rogers in his article "On the Age of the Coal Rocks of Eastern Virginia," published in the "Transactions of the Association of American Geologists and Naturalists." Professor Rogers gives three measurements of sizes often found in the fronds. They may be distinguished as fronds A, B, and C. Dimensions of frond A: Width, 2.4 inches; estimated length, 14 inches. Frond

B has a width of 4 inches and an estimated length of 24 inches. Frond C has a width of 6.4 inches and an estimated length of 40 inches. The widths were measured and the lengths estimated from fragments large enough to give a good idea of the true size of the frond. It is necessary to estimate the lengths, as the plants are never, when of large size, complete. I have, however, seen fragments so nearly representing the entire length that I can confirm these estimates and measurements of Professor Rogers. The enormous number and wide diffusion of the specimens of this plant, and the different stages of growth which are preserved, afford a good deal of variation both in the size and shape of the impressions, so that sometimes one is tempted to suppose that he has a new species before him. I have, however, found in all cases that the nervation remains the same. I have obtained this plant in all stages of growth, from the very young form to the fully-grown leaf, and in all degrees of perfection of preservation. In many cases the shale is so fine-grained, and the plant presented in so many aspects from the maceration which it has undergone, that I have been enabled to make a very satisfactory study of it.

The young plants represented in Plate II, Fig. 3, and Plate III, Fig. 2, are seen to assume a rather broadly elliptical form, thus differing greatly from the more fully grown plants. A marked character of the young frond is the great and sudden attenuation of the midrib, which occurs about midway its length. Both Professors Rogers and Bunbury have called attention to the fact that two forms are quite common in the more fully grown fronds. One form is elongate, and gradually narrows at the summit, giving the frond an oblong-lanceolate outline. This I have represented in Plate IV, Fig. 3, which is a much reduced outline of a full-grown leaf. The other form has the summit more bluntly rounded off, and possesses an oblong spatulate shape for the whole leaf. This is represented much reduced in Plate IV, Fig. 4. Plate V, Figs. 1 to 3, represent one of the obtuse fronds of natural size, as made out from a nearly complete specimen. Plate III, Figs. 1, 1*a*, represent one of the smaller acute fronds of natural size, and Plate III, Fig. 3, gives the summit of a larger frond of the same shape, also of natural size. Plate IV, Fig. 2, represents a rather unusual shape of the plant, where the length is great in proportion to the width, and in which the undulations do not appear on the margins of the leaf. While the upper part and termination of the leaves usually show a very regular curve in their margins, we find towards the middle and lower portions a more or less distinct undulation, which often becomes very marked towards the base. The fronds all narrow gradually towards the base and the lamina rather suddenly ceases, one-half being usually more prolonged than the other. The midrib is prolonged for some distance into a rachis that supported the frond, which latter is of course single. The frond seems to have been thin when we consider its great size, but the epidermis was strong and durable. It may often be stripped off from the fine-grained shale like thin paper. This epidermal tissue has, in the Hanover Area, formed a local deposit of coal 4 or 5 inches thick. It seems that here immense numbers of the leaves of this plant were accumulated in an eddy of the water, and being heaped one over the other, give us a coal composed of epidermal tissue mainly. The epidermis becomes greatly thickened near and over the midrib, so that the insertions of the lateral nerves are mostly hidden, and the midrib appears to be much wider than it really is. When this portion of the epidermis is removed by maceration, as it often is, the true nature of the lateral nerves, their insertion, and the true width of the midrib are disclosed. All of these points cannot be made out when the epidermis covers the fossil. Professor Rogers seems to have made his study of the plant from specimens which retain the epidermis, and hence he failed to note some of the characters of the fossil.

The midrib was evidently fleshy in nature, and had but comparatively few woody bundles. It owed much of its strength and rigidity to the strong, thick epidermis that covered this portion of the plant. It is as flat as a ribbon, and in those plants which are freed from the epidermis it is seen to be composed of but few nerve-bundles, which appear to have been immersed in a rather soft and succulent material, which, readily yielding to pressure, became perfectly flat on the thinly-laminated and fine-grained shale. When the thick epidermis over and near the midrib is in place it conceals the insertion of the lateral nerves. These, then, often appear to issue as single nerves, when, if the epidermis be stripped off, they are seen to fork very commonly close to their insertion. The striations seen on the midrib are the nerve-bundles showing through the epidermis. Seen on well-preserved specimens, with the epidermis in place, the lateral nerves appear simple, but when the plant has been subjected to maceration and pressure it is perceived that they are really nerve-bundles, composed of two and sometimes three fine thread-like nerves, which are usually so closely connected as to appear to be a single nerve. I had often been struck, when viewing the nerves on well-preserved impressions of the plant in which the epidermis was retained, with the fact that they seem very vaguely defined, considering their apparent strength. Closer examination of other specimens showed that this vagueness in the outline of the nerve is due to the tendency of the component filaments to separate from one another and to spread out under the influence of pressure and maceration. Plate V, Fig. 4, much enlarged, shows this compound nature of the nerves, and also the insertion of the lateral nerves, as well the way in which it is hidden by the thick epidermis near the midrib. Plate V, Fig. 4*a*, still more enlarged, shows three filaments in the nerve-bundles. The fructification shown on Plate IV, Fig. 1, if it be fructification, appears in the specimen seen by me in the form of elliptical depressions placed on the midrib from the middle of the leaf towards the base. They are drawn of natural size in Fig. 1 and enlarged in Fig. 1*a*. They are surrounded by a raised line which, sweeping sharply around the ends of the depressions, continues double until a divergence again takes place to embrace the next depression. Professor Rogers says that on many specimens he found an irregular row of circular depressions on each side of the midrib, and not unfrequently on the midrib itself. He states that they are placed at unequal intervals apart, and at rather varying distances from the midrib. He considered the depressions as indicating the positions of the sori, and I agree with him. I have not, however, seen these depressions otherwise than in the form shown in Fig. 1. They are rare, for I have seen but one distinctly-marked specimen. On Plate IV, Fig. 1, in the three groups of nerves, *a*, *b*, *c*, I have depicted the three principal modes in which the nerves depart from the midrib. They are, however, not grouped in this way, but the different kinds alternate with one another, and with single nerves. *Macrotæniopteris magnifolia* seems to be most nearly allied to *Macrotæniopteris gigantea* of the Rhætic of Europe, and to *Macrotæniopteris lata* of India. Schenk's plant, as figured on plate xxviii, fig. 12, in his work on the Rhætic Flora, represents the lateral nerves much as they are in our plant, but the chief difference seems to lie in their greater slenderness and remoteness, being in *M. gigantea*, one millimeter apart, while in the Virginia plant they are not more than one-half millimeter apart. Schenk's figure does not show the entire midrib, but Nathorst gives a figure of this plant in his "Floran vid Bjuf," plate ix, fig. 1, in which the flat, broad midrib is well shown and where we see a non-striated border on each side, which evidently is the insertion of the lateral nerves concealed by the thick epidermis investing the midrib. The nerves of the Swedish plant also agree closely with those of the Virginia fern, except that they appear to maintain a course more oblique to the midrib. As this feature is not shown in Schenk's plant, where they are soon perpendicular to the midrib, it is probably due to oblique compression. *Macrotæniopteris lata*, *Tæniopteris lata*, of Oldham and Morris, as depicted in fig. 1, plate II, of the "Palæontologia Indica," series ii, 1, is strikingly like our plant. The chief difference seems to be that the Indian plant has a more prominent, a more woody, and narrower midrib than the Virginia fern. I am strongly inclined to think that these three plants are all representatives of the same type-form, differing only in such minor features as would be produced in regions so remote from one another as Virginia, Northern Europe, and India.

Formation and locality.—This is the most widely diffused, abundant, and characteristic plant in the Mesozoic strata of Virginia. It abounds in the strata connected with the main coal seam, and is found everywhere in the Mesozoic at this horizon and above it to the top of the series. It is often found alone, but very commonly occurs with *Equisetum Rogersi*, and the two often occur alone. It must have grown in the same localities with the Equisetum or very near to it.

Macrotæniopteris crassinervis, Feist.

Plate V, Fig. 5; Plate VI, Figs. 1, 2.

Frond simple, coriaceous, margins thickened, length ? width up to 17 centimeters. Midrib prominent, rounded, and rigid. Lateral nerves strong and cord-like, slightly thickened towards the insertion, one millimeter, and sometimes a little over, apart, single, making a right angle, or one a little less than a right angle, with the middle nerve, or midrib, parallel.

Plate VI, Fig. 1, represents, apparently, a portion towards the summit of a frond. Plate V, Fig. 5, gives a fragment of a larger frond, on which the margins are wanting. The character of the lateral nerves on this specimen on the right-hand side, seems to be the normal one, that is, they are slightly oblique. On Plate VI, Figs. 1, 2, they are at right angles to the middle nerve and margin. In Plate VI, Fig. 2, we have enough of the frond preserved to give us the width of one of the plants of large size. The width of this specimen was at least 17 centimeters, and the frond must have in all its dimensions rivaled the largest of the specimens of *M. magnifolia.* It will be noted that the margin of the specimens given in Plate VI, Figs. 1, 2, is represented as having a thickened and rigid border. This is true of *M. magnifolia* also, but the thickened margin is in that plant less obvious than in *M. crassinervis.* This character of the margin enables us easily to determine when the lamina is entire, and when apparent undulations are due simply to laceration.

I have identified this plant, without hesitation, with Feistmantel's plant found at Murero and Buskoghat, in the Rajmahal Group of India. Feistmantel says, however, that his plant is not large. The representation given of it in "Pal. Ind.," series ii, 7, on plate xxviii, in figs. 1, 2, 3, 2*a*, 2*b*, clearly shows that the specimens were fragmentary, and did not give the entire width of the frond. The undulation of the margin noted by Feistmantel is evidently due to the laceration of the margin. These figures show plainly that the India plant is the same with that from Virginia.

This species is one of the most clearly defined of all the forms of Macrotæniopteris. Its strongly prominent and rigid midrib is not much flattened, and is sharply distinct from the lamina of the frond on each side. The lateral nerves are very distinct, and stand out like threads, even on sandstone, the only rock which contains it. The plant is very rare. I have never seen any specimens anywhere except at Clover Hill, and here it occurs only with a few fragments in a rather siliceous sandstone under the main seam. It is associated in this sandstone with plants found as yet only here.

Formation and locality.—Clover Hill, in sandstone under the main coal, and between it and the bottom seam.

ACROSTICHIDES (ACROSTICHITES Goeppert).

Frond bipinnate or tripinnate. Pinnæ linear-lanceolate, usually much prolonged. Pinnules various, ovate-oblong, ovate, ovate-subfalcate, rounded, and subrhombic. Middle nerve of the pinnules vanishing towards the apex, being dissolved into branches. Lateral nerves depart from the middle nerve under an acute angle, the lower ones forking more frequently than the upper ones. Fructification in the form of rounded sporangia, covering the whole of the under surface of the pinnules and placed between the nerves.

I have defined this genus nearly as Goeppert does. It is difficult to limit the character of the pinnules since they vary a good deal in the sterile forms, and the fertile pinnules often differ from the sterile ones. We may, however, distinguish two types in the shape of the sterile pinnules. One is ovate, or ovate-subfalcate, as shown in *A. Gœppertianus* and *A. linnææfolius.* The other is broadly ovate, approaching a quadrilateral and rhombic form, as shown in *A. pachyrachis* and *A. rhombifolius.* This latter type is especially characteristic of the Virginia Mesozoic, as we find several species showing it.

This genus is very characteristic of the Rhætic formation, all the forms included in it being found in the Rhætic except *A. Williamsoni*, which occurs in the Oölite of England. The following previously described species are to be included in this genus: *Neuropteris linnææfolia*, Bunbury, from the Richmond Coal Field; *Acrostichites Gœppertianus* and *A. princeps*, Schenk, from the Rhætic of Europe; *Cyclopteris pachyrachis*, Goeppert, from the Rhætic of Bamberg, and *Pecopteris Williamsoni*, Brongt., from the Oölite of England. Schimper says in his "Pal. Vég.," vol. iii, p. 476, that the *Cyclopteris pachyrachis* of Goeppert, which in his first volume he had considered as a Neuropteris, ought to be placed in his section of *Pecopteris acrostichides*, which he had limited pretty much as Goeppert had defined his genus *Acrostichites.* He states, in addition, that the species *Acrostichites Gœppertianus* and *A. princeps*, as well as *Pecopteris Williamsoni*, along with *Cyclopteris pachyrachis*, might well form a group distinct from others. In his description of *Neuropteris linnææfolia*, in which he follows Bunbury, he says that this plant is probably the type of a new genus, and although he had only the fructified form of the fossil as figured by Bunbury, he placed it alongside of *Cyclopteris pachyrachis.* Heer also has stated that *Neuropteris linnææfolia* resembles *Cyclopteris pachyrachis.*

It will thus be seen that the Virginia plant, even in its greatly disguised fructified form, betrays its affinity with the other plants of the genus *Acrostichides,* some of which, as *Cyclopteris pachyrachis,* have not been found fructified.

Acrostichides linnææfolius (Bunb. species).

Plate VI, Fig. 3; Plate VII, Figs. 1–4; Plate VIII, Fig. 1; Plate IX, Fig. 1.

Neuropteris linnææfolia, Bunbury.

Frond bi- or tripinnate. Rachis channeled on the upper side. Pinnæ linear-elongate, subopposite or alternate. Pinnules of sterile and fertile fronds different. Sterile pinnules ovate-subfalcate, acutely or obtusely terminated, distinct to the base, where they are slightly rounded, attached by the entire base. Pinnules of the fertile frond rounded or semicircular, slightly heart-shaped at base, and separate to the insertion. Pinnules of both fertile and sterile fronds subopposite or alternate. Mid-nerve of sterile pinnules stout at base but vanishing towards the apex, being dissolved into branches; lateral nerves of the same departing obliquely from the middle nerve, the lower ones several times forked, the upper ones less frequently forked. On each side of the insertion of the middle nerve a group of fascicled nerves is found. All the lateral nerves curve strongly towards the margin. Middle nerve of the fertile pinnules stout at the insertion, and, by repeated branching in a flabellate manner, filling the greater part of the pinnule. A group of lateral nerves departs from the rachis of the pinna on each side of the insertion of the middle nerve, and the branches curve strongly to meet the margin of the pinnules. Fructification in the form of rounded sporangia placed between the branches of the nerves, and covering the under side of the pinnules, giving them a granulated appearance.

Specimens of this beautiful fern in the fructified form were obtained by Sir Charles Lyell, and were described by Bunbury in the "Quarterly Journal of the Geological Society," vol. iii, where he gives in plate x a good figure of the plant, naming it *Neuropteris linnææfolia.* This specimen shows well the leading characteristics of the plant, but seems to have suffered a good deal from maceration, which has disguised the insertion of most of the pinnules, rendering them too much narrowed at base. I was fortunate enough to find, in my visit to Midlothian, on the mantel of an old gentleman who had, thirty years before been a miner of coal in this vicinity, a large slab of very fine-grained shale, of light gray color, on which were large impressions of several species of plants, beautifully preserved, with all the carbonaceous material of the plants in place. This slab had been taken from the roof-shales of the main coal, in a shaft long since filled up, at a locality near Midlothian. It was preserved solely on account of the beauty of the impressions found on it. Among the plants found on this slab was the large fragment of *Acrostichides linnœæfolius* depicted in Plate IX, Fig. 1. To judge from the number and size of the different specimens found on this slab, and the perfection of their preservation, this locality must have been remarkably rich in fine impressions. The shaft from which they were obtained is the "Gowry."

All the leaf substance being preserved on this specimen from the Gowry in great perfection, we are enabled to make out many details which could not otherwise be observed. The portion of the frond figured was most probably a primary pinna of an arborescent fern. The pinnæ are extremely long and slender, and are sometimes opposite. The rachis is marked with two lateral ridges, one on each side, bordering a depressed channel. This is also seen on Bunbury's specimen. The plant must have been a very robust one, and probably was arborescent, for the specimen delineated in Plate IX, Fig. 1, seems to be a primary pinna. The leaf substance of the fertile pinnæ was thick and coriaceous, leaving, after being compressed in the shale, a shining, granulated, and somewhat convex impression. The pinnules are often crowded, and sometimes somewhat imbricated. The nerves are in both the sterile and fertile pinnules slender but strongly marked, and distinctly defined. In Plate IX, Fig. 1 *a*, I have given on the magnified pinnules both the nervation and fructification of the fertile portion of the plant. What the relation in position of the sterile and fertile portions of the fronds to each other is I cannot say. I have never seen any sterile pinnules on the fertile portion of the frond, or *vice versa.* The pinnæ were extremely long, and as a consequence their tips are almost without exception wanting. In Plate VII, Fig. 3, I give a representation of the only termination that I have seen. In Plate VII, Fig. 4, I give a delineation of fertile pinnules that show a transition in shape approaching that of the sterile pinnules.

I visited the old Gowry Shaft, now filled up, and found, after careful search on the "dump," several impressions that I consider as the sterile form of this plant. At first sight they do not appear to be the same species, but a careful inspection of the shape of the pinnules, and the plan of the nervation, would soon convince one that these forms are essentially the same with the fructified plant called, by Bunbury, *Neuropteris linnææfolia.* I have never found the sterile or fertile forms anywhere but at this shaft. Bunbury obtained his plant from the Blackheath Mine, which is in the same vicinity. I give in Plate VI, Fig. 3, and Plate VIII, Fig. 1, representations of the sterile frond. One of the forms (Plate VI, Fig. 3) has the pinnules more bluntly terminated and a stouter principal rachis, indicating that the specimen belongs to the lower portion of the frond. Plate VIII, Fig. 1, represents a portion higher up on the frond, where the pinnules are more acute, elongate, and falcate. Plate VI, Fig. 3 *a*, represents a magnified portion of Fig. 3, giving the nervation, while in Plate VIII, Fig. 1 *a*, magnified pinnules of Fig. 1 are represented. In both forms the pinnæ are closely placed, and overlap one another. The base of the pinnules of both forms is slightly rounded on each side. A slight modification of both kinds of pinnules, shortening and rounding them, would give us the form of the pinnules of the fertile frond. Hence, even without the aid of the transition pinnules, such as are shown in Plate VII, Fig. 4, there would be no difficulty in identifying these sterile forms as belonging to the same plant as the form described by Bunbury. The consolidation of the pinnules in becoming fructified, by being shortened and rounded, seems to be a not uncommon feature in Acrostichidēs. It is shown in the *Acrostichites Gœppertianus* of Schenk, and more markedly in *Acrostichides rhombifolius* to be presently described. It will be noted that Schenk's plant shows the same channeling of the stem as appears in our plant. This feature also is seen in *A. rhombifolius* in a very marked manner. It does not appear in Plate VIII, Fig. 1, for here the lower side of the rachis is no doubt seen, and this is rounded or convex.

These sterile forms of *Acrostichides linnææfolius* are no doubt the same plant as that described by Bunbury, and also by Rogers, as *Pecopteris Whitbiensis.* They have a marked resemblance to some of Brongniart's figures of this plant, and this is especially true of the form delineated in Plate VIII, Fig. 1. I may perhaps be permitted to remark in this connection that it seems to me that some authors have gone too far in identifying various plants with *Pecopteris Whitbiensis.* The sterile forms of the Jurassic Acrostichides and Cladophlebis have a good many features in common, and in the absence of fructification all these plants, however diverse, would be reduced to *Pecopteris Whitbiensis* if this custom be followed. Certainly Professors Rogers and Bunbury would in that case be justified in announcing *Pecopteris Whitbiensis* as found in the Richmond Coal Field. Again, it seems to me that Lindley and Hutton's *Pecopteris Whitbiensis* is a very different plant from that of Brongniart. Schimper, I think, went as far as was proper when he proposed to group the Jurassic ferns with no known fructification, having a resemblance to *Pecopteris Whitbiensis,* as plants of the type of *P. Whitbiensis.* He very properly later agreed with Saporta in assigning a generic value to the common features of these plants, and grouped them under the genus *Cladophlebis.*

Acrostichides linnææfolius seems to be a rare plant. I have never seen either the sterile or fertile forms anywhere but at the old Gowry Shaft. The only other locality yielding it, so far as I know, is the Blackheath Mine, from which Bunbury procured his specimen. The Blackheath occurs in the same part of the coal field as the Gowry.

Formation and locality.—Found at the Gowry and Blackheath in the roof of the main coal.

Since the above was written I have been so fortunate as to find among the specimens collected by Professor Rogers, while engaged in his survey of Virginia, and placed in the geological collection of the University of Virginia, a magnificent slab with an impression, finely preserved, of *Acrostichides linnææfolius.* This impression is 40 centimeters long, and shows a fragment of what seems to be a compound pinna. The rachis does not diminish much in diameter from the base to the summit of the specimen, and the great length of the uppermost ultimate pinnæ, viz., nearly 20 centimeters, together with this fact, seems to indicate that, large as the fragment is, it is only a small portion of the pinna from which it was derived. The ultimate pinnæ of the lower and middle portions of the specimens must have been over 20 centimeters long, and hence the width of the specimen must have been over 40 centimeters. I have drawn two pinnæ from the lower part of the impression and two from the upper, as the specimen is too large to be contained in any plate. In each case, although the left-hand pinnæ are taken, those on the right are equally long. Both figures give the natural size of the parts and the mode of insertion of the ultimate pinnæ. In Plate VII, Fig. 2, it will be noted that the pinnules near the principal rachis, and for some distance from it, have the rounded form of the normal *Neuropteris linnææfolia* of Bunbury. Farther off from the main rachis, and towards the summit of the ultimate pinnæ, the pinnules tend to lose their rounded form and finally to pass into normal sterile pinnules. The rounded pinnules are granulated with the sporangia. The ultimate pinnæ from lower down on the compound pinna have the pinnules fructified farther out from the main rachis or farther towards the summit of the ultimate pinnæ. The indications are that on ultimate pinnæ from portions of the plant still lower than any shown on the specimen, all the pinnules will be fructified and no sterile pinnules will be found on the same pinnæ with the fertile ones. As we ascend towards the summit of the compound pinna the fertile pinnules become less and less numerous, until from a little below the middle of the specimen they disappear, all the pinnules being sterile and of the form given in Plate VII, Fig. 1. In accordance with these facts, the diagnosis of the plant should be amended to read: Fertile and sterile pinnules sometimes on the same specimen; then the fertile pinnules stand next to the main rachis, and become more numerous in lower parts of the compound pinna, disappearing towards the summit of the same. The portion of the plant yielding the specimen from which the figures were taken could not have been less than a meter in length and about half a meter in width.

I am not able to tell from what locality the specimen now in question comes, but from the character of the rock I should think it was derived from the Gowry Shaft.

Acrostichides rhombifolius, spec. nov.

Plate VIII, Figs. 2, 3; Plate XI, Figs. 1–3; Plate XII, Figs. 1, 2; Plate XIII, Figs. 1, 2; Plate XIV, Figs. 1, 2.

Frond bi- or tripinnate. Principal rachis on the upper side, with a raised border on each side of a rather flat channel, on the under side, convex. Pinnæ very long and slender, linear in form, and narrowing slightly both towards the base and apex, subopposite or alternate. Pinnules of the sterile and fertile fronds are of different forms. Those of the sterile frond are nearly quadrilateral or rhombic in form, slightly rounded at base, and more or less acute at their extremities, being separate to the rachis of the pinnæ, and inserted by their entire base, either subopposite or alternate, the lowest pinnule on the lower side of the pinna being often inserted half upon the principal rachis of the frond. Pinnules of the fertile frond rounded or semicircular in form, thick, coriaceous, somewhat convex, and granulated by the fructification. Pinnules of both sterile and fertile fronds more and more united towards the extremity of the pinnæ and towards the upper part of the frond, while at the same time the pinnæ become shortened, until finally, towards the summit, the pinnæ are reduced to pinnules. Middle nerve of the fertile pinnules, none. Nerves composing about three groups, which spring from a point below the center of the pinnule and branching dichotomously and flabellately, fill the pinnule. Middle nerve of the sterile pinnules rather strong at its insertion, sending off branches from its base and at intervals higher up, the latter quite obliquely, and finally towards its summit being dissolved into branches. Lateral nerves lower down branching more frequently than those towards the extremity of the pinnules, all slender, but very sharply defined and distinct. Fructification in the form of rounded sporangia placed between the nerves and covering the under surface of the pinnules.

The large number of well-preserved specimens that I obtained of this fine species enables me to give a very complete account of nearly all parts of the plant. It seems to have been an arborescent species, and the large fragments depicted in the figures appear to be primary pinnæ which were once attached in a pinnate manner to some large rachis, as in the case of *A. linnææfolius*, causing the plant to be probably at least tripinnate. Plate XI, Fig. 1, Plate XII, Fig. 1, seem to represent the middle portions of the primary pinnæ, or it may be of the fronds. The channeled rachis is well marked in this species. The lower portion of the plant seems to have borne smaller pinnæ and pinnules, for Plate XI, Fig. 2, evidently represents a portion of the pinna or frond lower down than the parts given in the above-named figures. Perhaps this feature is analogous to the perceptible diminution in the size of the pinnules often seen in this plant toward the insertion of the pinnæ of the last order, which is an unusual feature. The pinnæ of the last order, or ultimate pinnæ, were very long and slender, so that their tips are almost never preserved. I have succeeded in finding only one distinctly shown. This is represented by Plate VIII, Fig. 2. Here the pinnules are seen to become more and more united, and the terminations of the pinnæ of the middle and lower parts of the plant perhaps thus possess the character of the entire pinnæ from the upper part of this fossil, where all the pinnules of the pinnæ are becoming united, as is shown in

Plate XII, Fig. 2. The lower pinnules on this specimen, Plate VIII, Fig. 2, show in a striking manner the peculiarly elegant shape which the pinnules of this plant often assume. I have on this account given an enlarged figure of one of these pinnules, Plate VIII, Fig. 2 *a*, which at the same time shows the nervation. The narrowing of the ultimate pinnæ towards their base is well shown in Plate XII, Fig. 1. I have given a series of figures representing the gradations of the ultimate pinnæ in passing into simple pinnules towards the top of the frond. Plate XII, Fig. 2, represents the pinnules nearly completely united. Plate VIII, Fig. 3, represents a part of the frond where the pinnæ are much diminished in length and width, and where a rounded lobing only is shown, while towards the summit of the specimen the pinnæ are nearly reduced to pinnules. In Plate XIII, Fig. 1, the pinnæ are now reduced to simple pinnules, the lowest ones showing still an undulation on the margin. These pinnules are more elongate-falcate, and stand more nearly perpendicular to the rachis than the normal pinnules of the middle and lower parts of the plant. In fact they are so much unlike these that if they were seen only in isolated specimens, they would be considered as belonging to a different species. I did so consider them until I was forced by the finding of passage forms, showing a complete gradation of one into the other, to unite them in one species. Plate VIII, Fig. 3 *a*, represents a magnified pinna of the lower part of Fig. 3; 3 *b* represents a magnified pinna of the upper part of the same.

Plate XIII, Fig. 1 *a*, gives a magnified pinnule of Fig. 1, where the seeming pinnules are really equivalent to the pinnæ of the lower parts of the plant. Plate XIV, Figs. 1 to 2, represent portions of fertile fronds. All the pinnules are granulated. Plate XIV, Fig. 2 *a*, gives a magnified portion of Fig. 2, and 1*a*, a magnified section of Fig. 1. It will be borne in mind that in most of the figures of the plants given in this memoir all the details are not represented in every portion of the plant when they are similar to those given in the parts which are completed. Plate XI, Fig. 3, represents a portion of a pinna magnified twofold, in which the fructified pinnules are semicircular and opposite, and also united for some distance. These are unusual features in this species. Plate XIII, Fig. 2, gives the upper part of a fertile frond, where the pinnœ are tending to pass into simple pinnules.

In Plate XIV, Fig. 2, the fertile pinnules are well rounded, and the plant is more slender than that represented in Fig. 1.

The larger sterile pinnules of *Acrostichides rhombifolius*, those coming from the lower parts of the frond, may be compared with two previously described plants. These are *Cyclopteris pachyrachis*, Goeppert, from the Rhætic of Europe, and *Neuropteris Schœnleiniana*, Schimper, from the Trias. It is a smaller plant than *Cyclopteris pachyrachis* in all respects, and especially the rachises of the primary pinnæ are much more slender. In the general aspect of the plant it much resembles the fine fern from the Keuper which has been so well figured by Dr. Schoenlein, and which Schenk has described. It is, however, a more delicate plant than this, and the pinnules are decidedly smaller. Still this fern of Dr. Schoenlein is perhaps its nearest relative among described plants.

Acrostichides rhombifolius is not very widely diffused. I have found the sterile form at the Gowry Shaft, and very sparingly at Clover Hill. Both sterile and fertile forms occur rather abundantly at Carbon Hill in the roof shales of the lower coal bed or the bed immediately below the main seam. This seems to be the horizon of the plant everywhere.

Formation and locality.—At Carbon Hill, at the Gowry, and at Clover Hill, over the lower coal bed.

Acrostichides rhombifolius var. rarinervis.

Plate XIII, Fig. 3.

The plant given in Plate XIII, Fig. 3, seems to differ from the normal species, *A. rhombifolius*, sufficiently to separate it as a variety. The pinnæ are alternate, and have a very stout rachis in proportion to their size, and it is bordered on each side by a raised line. The pinnules are smaller than in the normal species, shorter and more nearly quadrilateral in form, with the tips less produced. They are also more closely placed, and are frequently imbricated slightly. The chief difference lies in the nervation, which is more distinctly flabellate, and the branching of the nerves is less frequent, giving fewer nerves in the pinnule. The upper pinnules are united for some distance from the insertion, but the shape of the pinnules and their nervation are features quite different from what we find in the united pinnules of *A. rhombifolius.* Plate XIII, Fig. 3*a*, represents two pinnules of the lower part of the plant, and Fig. 3 *b*, two from the upper part, both magnified to show the nervation. The fertile plant was not found.

Formation and locality.—Found at Clover Hill only, in strata between the main and lower coal seams.

Acrostichides microphyllus, spec. nov.

Plate VII, Fig. 5; Plate X, Fig. 2; Plate XI, Fig. 4; Plate XII, Fig. 3.

Frond bi- or tripinnate. Fertile frond not seen, sterile frond, or primary pinna, with a rachis having on the upper face a raised line on each side bordering a channel, and on the under side convex. Ultimate pinnæ subopposite or alternate, distant, inserted at an angle of about 45°, very long, slender, and linear in form. Pinnules subopposite or alternate, very small, thick, and rather coriaceous, subrhombic or subquadrilateral in shape, inserted by the entire base on the rachis of the ultimate pinnæ which has a raised margin on each side. The lower pinnule on the lower side is often inserted half on the principal rachis. Nerves in about three groups, departing from a common point of insertion situated near the lower part of the pinnule, each group branching freely, the lower group sending off branches only on the lower side, the lowest of which curve strongly to meet the margin of the pinnule.

In many features this beautiful little plant resembles *A. rhombifolius*, and it evidently belongs to the same type of Acrostichides. It seems, however, to be specifically distinct, for the small size of the pinnules, and the linear, almost thread-like nature of the pinnæ of the ultimate order, are constant features, so that a specimen may be recognized at a glance. The stoutness of the principal rachis in Plate VII, Fig. 5, shows that this specimen belongs to the lower part of the frond, and if the plant be merely a small form of *A. rhombifolius*, the pinnules here should be of the normal size as seen in *A. rhombifolius.* The nervation is more slender than that of *A. rhombifolius*, and owing to the thickness of the leaf substance, cannot be seen distinctly in many cases. The very long and slender primary pinna shown in Plate X, Fig. 2, and the smaller form seen in Plate XI, Fig. 4, appear to belong to a different species from that represented in Plate VII, Fig. 5, and Plate XII, Fig. 3. These last mentioned forms show the nerves distinctly and sharply defined, though the leaf substance is thick and the nerves delicate. The slender specimens given in Plate X, Fig. 2, and Plate XI, Fig. 4, do not show any nerves, and the epidermis is very thick and coriaceous. These long and slender pinnæ, both primary and secondary, cover the face of the shale, in some cases, with numbers of pinnæ reduced almost to threads, and present a peculiar aspect not easily described. As they do not present any obvious points of difference from the normal *A. microphyllus*, I have not thought it proper, in the absence of nervation, to separate the plant, even as a variety. The fructification of none of these forms has been seen.

Formation and locality.—Rather rare at Clover Hill, in shaly sandstone, associated with the main coal seam.

Acrostichides densifolius, spec. nov.

Plate X, Fig. 1.

Frond bi- or tripinnate. Principal rachis slender, with a channel on the upper side. Ultimate pinnæ, with channeled rachis, subopposite, closely placed, and imbricated. Pinnules subopposite or alternate, separate to the base, closely placed and imbricated, ovate-subfalcate, thin and membranaceous. Nervation very distinct, but slender. Middle nerve stout at base, but dissolving into branches at the extremity, inserted near the lower part of the pinnule. Lateral nerves going off obliquely, and branched several times, the lower more frequently so than the upper. Fructified frond not seen.

The most characteristic features of this plant are the crowded pinnæ and pinnules, and the very distinct though slender nerves. Both the pinnæ of ultimate order and the pinnules overlap considerably. This overlap of the pinnules is seen in the magnified pinnules, Plate X, Fig. 1 *c*. Plate X, Figs. 1 *a*, 1 *b*, show the nervation, which is of the kind characteristic of the Virginia Acrostichides, and of the section of the genus with subfalcate pinnules. It will be seen that the shape of the pinnules here also tends to the subrhombic form.

This plant has a considerable resemblance to *Acrostichides linnææfolius*, but this has a peculiar rounded form at the base of the pinnules, showing a tendency to assume a heart-shape that is never seen in the plant now in question, and besides *A. linnææfolius* is never imbricated in the pinnules.

Formation and locality.—Very rare at Clover Hill, in strata associated with the main coal. It comes probably from above the main coal, and in connection with the series of small upper coal seams. It has never been found anywhere but at Clover Hill, and only two or three specimens were obtained.

MERTENSIDES, gen. nov.

Frond bi- or tripinnate, pinnæ of ultimate order, subopposite or alternate, long, and linear-lanceolate. Pinnules alternate, inserted at right angles, or nearly so, to the rachis of the ultimate pinnæ, fertile ones obtuse, sterile ones somewhat acute, all subfalcate and distinct to the base, except in the upper part of the primary pinnæ or fronds. Middle nerve of the pinnules dissolved towards the apex into branches, lateral nerves going off obliquely, the lower ones several times branched, the upper ones branching less often. Fructification in the form of large globose sori inserted on a branch of the lateral nerves, or on the summit of an unbranched lateral nerve, and composed of from 4 to 6 sporangia grouped around a central axis. Sori mostly confined to the lower half of the pinnules. Type, *Mertensides bullatus*, *Pecopteris bullata* of Bunbury.

The plants which I have grouped under the generic name of *Mertensides* have a great resemblance to the Mertensia group of the Gleicheniaceæ. The resemblance is sufficiently great, I think, to entitle these plants to rank as the precursors, and representatives of the Gleicheniaceæ, which, as Heer has shown, appear in force in the lowest Cretaceous beds of Greenland. The only point of difference between our plants and Mertensia, is in the absence of the dichotomous branching in Mertensides. They show a strong resemblance to Asterocarpus, but in Mertensides the fructification as a rule does not cover the whole pinnule, the upper portion being commonly free, and showing the nervation distinctly.

Mertensides bullatus (Bunb. spec.).

Plate XV, Figs. 2 to 5; Plate XVI, Figs 1 to 3; Plate XVII, Figs. 1,2; Plate XVIII, Figs. 1,2; Plate XIX, Fig. 1.

Frond bi- or tripinnate, perhaps arborescent. Principal rachis marked on the upper face with a strong ridge near the margin on each border, on the lower face rounded or cylindrical; ultimate pinnæ alternate, with a broad, flat rachis, having a strong woody cord running through the center of it, to which the middle nerves of the pinnules are attached, sterile and fertile pinnules slightly differing in form, but both with a thick leaf-substance; sterile pinnules rather more obliquely placed on the rachis than the fertile ones, and more acute and falcate; fertile pinnules inserted nearly or quite at right angles to the rachis of the ultimate pinnæ, oblong, with a slightly broadened base, bluntly rounded at the apex; pinnules of both sterile and fertile forms on the lower ultimate pinnæ, crenately notched on the margin; pinnules on the upper ultimate pinnæ, and toward the summit of the plant, united at base for a greater or less distance; those of the middle portions of the plant, or the normal pinnules, separate to the base, all inserted by the whole of the slightly widened base, on a rachis which appears to have been bordered by a thick coriaceous band, which causes it to appear much thicker than it really is. Lowest pinnule, on the lower side of the ultimate pinnæ of both sterile and fertile plants, always much larger than the rest, broadly spatulate in shape, deflexed along the principal rachis, and never containing fructification. Middle nerve dissolving into branches towards its summit, lateral nerves going off obliquely, the lower ones more freely branched than the upper ones, which branch once or twice, lateral nerves of the crenulated lowest pinnules branching several times so as to fill the crenulations, or lobes. Nerves of the deflexed heteromorphous lowest pinnules branching and diverging in a flabellate manner. Fructification consisting of large, prominent globose sori, which are composed of five or six sporangia arrranged radially around an axis; sori confined usually to the lower half of the pinnules, forming a row on each side of the middle nerve and placed about half way between the middle nerve and the margin of the pinnules, inserted on one of the branches of the lateral nerves, usually the lowest one, in pinnules with few sori, the pinnules then being broader than those that are fully fructified. The latter, or the fully fructified pinnules, are narrower than those which have their tips free from sori, or that are partially fructified, and they have the lateral nerves reduced to a single pedicel which bears the sorus. The sori are more numerous on the pinnules of the lower part of the frond and on the pinnules that occur midway on the ultimate pinnæ and toward their ends.

The great numbers of finely preserved and large specimens of this remarkable plant that I have obtained have enabled me to make a very complete study of it, and to present it in nearly, if not quite all of its numerous forms. I have very fully illustrated it, selecting typical forms from many hundreds that have passed under my eyes. I hope that the peculiar features of the plant will excuse the number of figures given. I will say here that were it not for the deflexed spatulate pinnule, which is unmistakable, I would have been tempted to make several species out of this single plant. This is a possible error that should always be borne in mind when one has only a few specimens of a plant before him. The sterile forms differ from some of the fertile forms quite enough to excuse their separation as a distinct species in the absence of some such guide as the spatulate pinnule. It will be noted that this deflexed spatulate pinnule is the most obvious characteristic of the plant. It resembles the similarly placed heteromorphous pinnule of Odontopteris. The only plant of the younger formations that has a feature like this is the *Pecopteris lobifolia* of Lindley and Hutton, found in the Oölite of Yorkshire, England. Our plant is of course not to be identified with this, on account of the numerous obvious points of difference. Bunbury first described the plant now in question under the name *Pecopteris bullata.* His specimen was evidently very imperfect, and did not show the heteromorphous pinnule, as he does not give the portion of the plant occupied by this pinnule in his figure in the article in the "Quarterly Journal of the Geological Society." Bunbury's specimen has its pinnules distorted by being pressed into the shale. They thus appear narrower at base than they should be.

This plant seems to be the same with the Pecopteris, compared by Professor Rogers with *Pecopteris obtusifolia* of Lindl. and Hutt, but which he does not name. Professor Rogers seems to have obtained a very imperfect specimen. The rachis of the ultimate pinnæ is usually very broad and flat, and has in its center a prominent woody portion, to which the middle nerves of the pinnules are attached. This seems to be bordered by a thick leathery margin which may be really a sort of wing. The bases of the pinnules are attached to this, but their middle nerves pass through it to join the woody central axis. This axis is well shown in Plate XV, Fig. 2, where the margin is quite wide, and makes the rachis appear to be very broad The principal rachis is quite strongly ridged on each side, and is often very strong, being sometimes more than a centimeter wide. I have seen some fragments of the primary pinnæ that were over 45 centimeters long in which the spread of the ultimate pinnæ was 30 centimeters. These all appear to be pinnæ belonging to an arborescent plant. The upper pinnules, especially of the sterile frond, are united for a considerable distance above their bases, while the pinnules of the lower fertile pinnæ become crenately lobed, and tend to pass into pinnæ. The shape of the fertile pinnules is very constant and characteristic. They have a slightly expanded base, but above the base are oblong, slightly falcate, and very bluntly rounded off, while they stand nearly or quite at right angles to the rachis upon which they are inserted. The sterile pinnules have a somewhat different shape. They have a proportionally broader base, are more obliquely inserted, and are more acute and falcate. The nervation is the same in both sterile and fertile pinnules, and the heteromorphous pinnule is present in both sterile and fertile fronds. This pinnule sometimes becomes very large, as is shown in Plate XV, Figs. 4, 5, both of natural size.

The fructification shows many points of interest. As a rule the sori are comparatively few, and irregularly scattered on the pinnules nearest the principal rachis, while none are ever found on the deflexed heteromorphous pinnule. They become more numerous in the pinnules and more regularly placed as they depart from the main rachis. They are most numerous on the pinnules of the lower pinnæ, and diminish in number in the pinnules of the upper pinnæ, where they often become very few and even single, and are scattered irregularly on the pinnules. These features are well shown in Plate XVI, Fig. 1, where we have only single sori in the uppermost pinnules, and also in Plate XVIII, Fig. 1, where they are seen to diminish in number on the pinnules toward the principal rachis. On by far the greater number of fructified plants the sori occupy only the lower half of the pinnules, and then the nerves are plainly to be seen in the ends of the pinnules. This feature is shown in Bunbury's figure. Plate XVI, Fig. 1*a*, represents a pinnule not fully fructified, where the tips are free from sori. They are the magnified pinnules of Fig. 1. More rarely we find the pinnules fully fructified and bearing sori to the summit, as represented in Plate XVIII, Fig. 2. These pinnules are narrower and more elongate than the partially fructified pinnules represented in Plate XVI, Fig. 1. The nerves here are, so far as seen, only in the form of pedicels bearing the sori, while the pinnules represented in Plate XVI, Fig. 1*a*, show that the sori are borne on a lower branch of the lateral nerves. The sori appear somewhat differently, according to the manner in which the imprint has been formed. Very often they appear as raised globose prominences which, under a strong lens and when exceptionally well preserved, show the compound nature of the sorus. In other cases they appear as pits rounded in shape, with a central circular depression, caused by the axis. In this form they are represented in Plate XVI, Fig. 1*a*. When the structure can be made out, the sori are seen to be composed of five or six sporangia ranged around an axis, as seen in Plate XVIII, Fig. 2*a*, which represents a fully fructified pinnule of Fig. 2. Here the nerves are obliterated, or at least cannot be made out, except the basal portions of the lateral nerves, which attach the sori to the middle nerve.

The fructification of this plant resembles that of Laccopteris but the frond is not digitately divided, as in that genus. Plate XVIII, Fig. 1, represents the lower portion of a large specimen in which the pinnules are crenately lobed. Plate XV, Fig. 3, represents a pinna from a similar portion of the plant in which the fructification is wanting. Fig. 3*a* represents a magnified pinnule of the same. Plate XIX, Fig. 1, represents a portion of the frond as it appears when seen from the upper side, the entire leaf-substance being preserved. As this is thick and coriaceous, the sori and nerves do not appear distinctly. In this specimen no sori appear on the pinnules of the upper pinnæ. The ridged upper surface of the principal rachis and the woody cord of the central portion of the ultimate pinnæ are plainly shown in this specimen. Plate XVII, Fig. 1, gives a portion of the middle part of a sterile frond or primary pinna, Fig. 1*a* represents the nervation of a magnified pinnule of this specimen, and Fig. 1*b* the heteromorphous pinnule as here shown. Plate XVII, Fig. 2, gives a portion of the upper part of a sterile frond, and Fig. 2*a* the nervation of a magnified pinnule of the same. Plate XVI, Fig. 3, gives a somewhat abnormal form of the upper part of a sterile specimen where the pinnules are more ovate than in the normal form, and the heteromorphous pinnule less heteromorphous than usual. Plate XVI, Fig. 2, gives still another abnormal form. Plate XV, Fig. 2, gives the normal form of the lower portion of a plant of large size. Fig. 5, same plate, gives a fragment of a heteromorphous pinnule seen detached from its rachis, and of natural size. It shows the great size that some of these pinnules attained. Plate XVI, Fig. 1, represents a fructified form of common occurrence, in which the sori of the upper pinnules become few in number and are irregularly placed. Plate XVIII, Fig. 2, represents a fully fructified form of the plant which is not uncommon.

Formation and locality.—Abundant in the shales and shaly sandstones over the lower coal at Carbon Hill and Clover Hill; found also at the Gowry shaft near Midlothian. Bunbury gives Deep Run in addition.

Mertensides distans, spec. nov.

Plate XV, Fig. 1.

Sterile frond not seen. Fertile frond bi- or tripinnate, perhaps arborescent. Frond, or primary pinna, very long and apparently linear-lanceolate in outline. Ultimate pinnæ linear in shape, and subopposite. Pinnules thick and coriaceous, remotely placed and alternate, standing nearly at right angles with the rachis, very small, ovate-oblong, subfalcate, inserted by the entire base, and bluntly rounded at the ends. Nervation not disclosed. Fructification in the form of sori, composed of about 4 sporangia, grouped radially around an axis, and occupying the lower half of the

pinnules. Sori on the pinnules of the lowest pinnæ few, and often single, irregularly grouped; those of the pinnules of the upper part of the frond more numerous, and at most 2 to 3 on each side of the midrib.

This small plant has a striking likeness to the Gleicheniaceæ in the smallness of the pinnules, their coriaceous character, and the small number of sori, which in the lower pinnules are often single on a pinnule, or one on each side of the middle nerve. The leaf substance is so dense that no trace of the nerves, except the middle nerve, can be made out. The sori are very large in proportion to the size of the pinnules, and increase in number from the lower to the upper portions of the plant. The very considerable distance apart of the pinnules is a noteworthy feature. They are frequently, especially in the middle and upper parts of the plant, placed at a greater distance apart than half the width of the pinnules. Plate XV, Fig. 1, represents what is evidently a portion of a very long and slender frond or primary pinna. From the rigid and stout character of the primary and secondary rachis, it would seem to be a primary pinna from some large frond.

It is strikingly like *Gleichenites microphyllus*, Schenk, from the Rhætic of Germany, see "Flora der Grenzschicht," plate xxii, figs. 7, 8. The only difference is that the pinnules of the Virginia plant are more remotely placed. In this point it is nearer to Heer's *Pecopteris gracilis*, from the Trias of Europe. Schenk says that he would have considered his plant as identical with that of Heer, were it not that his observations showed that none of the plants of the Trias were identical with any of those of the Rhætic. This, I think, is not a sufficient reason for separating them. At any rate, our plant is very closely allied to both of these.

Formation and locality.—Very rare at Clover Hill, in argillaceous, flaggy sandstone, probably from above the main coal, and associated with the group of small coal beds.

ASTEROCARPUS, Goeppert.

I place, with a good deal of hesitation, the following two species in Goeppert's genus Asterocarpus. They have some resemblance to the plants grouped as Mertensides, but on the whole seem to approach nearer to the genus Asterocarpus than any other. They may, with all the greater propriety, be placed in this genus, as this is acknowledged to resemble closely Mertensia. Indeed, Weiss thinks that Laccopteris ought not to have been separated from Asterocarpus, and that both much resemble the Gleicheniaceæ. My chief reason for separating these plants from Mertensides is the fact that the pinnules are always fully fructified.

Asterocarpus Virginiensis, spec. nov.

Plate XIX, Figs. 2-5; Plate XX, Figs. 1, 2; Plate XXI, Figs. 1, 2; Plate XXII, Figs. 1-3; Plate XXIII, Figs. 1-4; Plate XXIV, Figs. 1, 2.

Frond very large, probably arborescent, rachis sometimes 2½ centimeters thick, tripinnatifid or quadripinnatifid, quite polymorphous. Ultimate pinnæ opposite or subopposite. Pinnules of sterile and fertile plants different, all thick and coriaceous. Pinnules of the sterile plant, in the uppermost portion of the frond, or primary pinnæ simple, with entire borders, subopposite or alternate, oblong, bluntly rounded at the summit, very slightly falcate, and slightly decurrent, those of normal size 28 millimeters long and 8 millimeters wide in the middle; terminal pinnules obliquely inserted, decurrent, and united for a considerable distance. Sterile pinnules in proceeding to lower portions of the frond become first undulate on the margins, then crenately lobed, and finally cut into ovate acute lobes, which are separate to below their middle, thus causing the pinnules to pass into pinnatifid pinnæ. Pinnules of the fructified frond undergoing the same modifications from the upper to the lower part of the frond as the sterile pinnules, but narrower, very thick, and dense, more acute and more distant, decurrent by a broad wing; nerves varying much with the different parts of the plant and the different forms of the pinnules; in the fertile pinnules they are obliterated, except the very thick middle nerve, and single strong lateral nerves bearing the sori. In the sterile pinnules of the upper part of the frond the midrib is strong, but dissolves into branches towards the apex. Lateral nerves of the lower part of the pinnule grouped, three nerves going off from the same point of insertion, the middle one being forked near its base. In the middle and upper part of the pinnules the lateral nerve forks at its insertion, and the upper branch forks again near its base. All the branches are strong, sharply defined, and prominent, and curve strongly outwards to meet the margin of the pinnule. In the undulate and crenulate pinnules the lateral nerves fork so as to form flabellate groups which fill the lobes. In the pinnatifid pinnæ of the lower portions of the frond each ovate lobe has a middle nerve which at base is strong, but towards the apex dissolves into branches. The lateral nerves go off in part from the rachis of the pinna, and also from the middle nerve of the lobe, and are once forked; all are strong and very distinct. Fructification in the form of rounded sori, composed of 5 or 6 sporangia, grouped radially around a central point, and forming two rows, one on each side of the middle nerve. The lower row is decurrent, occupying the wing of the pinnules. Sometimes the sori are found only on the ends of large pinnules of the normal sterile form. These are then much narrowed in the parts occupied by the sori, but otherwise unchanged.

This plant is one of the finest and most interesting in the coal field. I have been enabled to obtain a large number of well preserved specimens of it, which show its very polymorphous nature and the many peculiarities presented by it. In the first place the fructification presents a very different aspect according as the upper or under surface of the pinnules, or the imprints of these, are seen. The imprints of the upper surface of the fructified pinnules, or the upper surface itself, present the form given in Plate XXIII, Fig. 1. This figure represents the imprint of the upper surface of the fructified pinnules of large size, and Fig. 2 the imprint of the same surface of the lobed pinnæ of the lower portion of the plant. It will be noticed that the sori appear here as elongated swellings, occupying the place of the lateral nerves. They have the general character of the fructification usually assigned to the fossil genus Asplenites. The sori, however, are really round, as may be seen when the under side of the pinnules is presented to view with the leaf-substance preserved, and have the character described. The peculiar elongation shown when the upper side or its imprint is seen is caused by the fact that the rounded sorus and its strong nerve, when pressed against the thick, dense leaf-substance of the pinnules, do not present a sharply defined outline of the separate parts when seen from the upper side, but the sorus and nerve produce a club-shaped prominence in which the sorus occupies the thickest part. I think that the same thing would happen when any thick coriaceous pinnules were pressed down upon a yielding substance like shale with its lower surface in contact with the shale. Hence many of the apparent elongated sori of the type of Asplenites may really be rounded. Plate XXIII, Fig. 4, represents the imprint of the under side of the large fructified pinnules, and gives the termination of one of the pinnæ. Plate XXII, Fig. 2, gives the form presented by pinnules, which are fructified only at the ends. The rest of the pinnule has the usual nervation and other characters of the large sterile pinnules. This specimen had all the leaf substance of the plant preserved, and showed the under side of the pinnules with the sori. Plate XXIV, Figs. 1 and 2, represent forms in which the pinnules are more remote than in the normal forms. They may belong to a variety of *Asterocarpus Virginiensis*, sufficiently distinct to be separated as such; but as the plant in question shows a great tendency to vary without losing its essential characters, I have thought it best to unite it with this somewhat abnormal form. Plate XXIII, Fig. 4 *a*, is an enlarged portion of Fig. 4, giving the form of the sori which is the same as that found in the sori of Figs. 1 and 2. Plate XXII, Fig. 1, gives the normal form and size of the pinnules from the upper part of the frond, where the pinnatifid pinnæ of the lower part of the frond are reduced to simple pinnules. Fig. 1*a*, gives the nervation of one of these pinnules. Plate XIX, Fig. 4, represents a character sometimes seen where the middle nerve of the pinnules becomes very broad and flat, almost ribbon-like. Plate XXI, Fig. 2, gives normal pinnules somewhat more remote than usual, and broader. Plate XIX, Fig. 5, represents a portion near the upper end of one of the ultimate pinnæ. It shows that the pinnules here are very decurrent, and are united for a considerable distance. I have not in a single instance seen the end of one of these large upper pinnæ. Plate XIX, Fig. 3, gives a portion of one of the pinnæ near its end, where the pinnules are united for a considerable distance. It, as well as Fig. 5, shows the manner in which the lateral nerves go off from the rachis of the pinnæ in these uppermost pinnules. Plate XXIII, Fig. 3, gives a portion of one of the pinnæ with very long pinnules, the lowest of which are undulate on the margin. In Plate XXI, Fig. 1, we have 7 pinnæ which evidently go off from a rachis not shown in the specimen. They show the graduation from simple pinnules to undulate and crenate pinnules. Fig. 1 gives an enlarged pinnule of this specimen to show the nervation and Fig. 1*a* a portion of another. In Plate XX, Fig. 1, we have three pinnæ from a lower portion of the frond which show the increasing depth of the lobation. Fig. 1*b* is an enlarged portion of the upper pinna to show the nervation, and Fig. 1*a* is from a lower pinna likewise enlarged to show the nervation. Plate XIX, Fig. 2, represents the pinnatifid pinnæ from the lower part of the frond corresponding to the simple pinnules of the upper part, and Fig. 2 *a* gives enlarged lobes of a portion of one of these pinnæ to show the nervation. Plate XXII, Fig. 3, represents what is probably a portion of the stipe, and the branch *a* may be the base of a rachis bearing pinnæ such as those in Plate XX, Fig. 1. This would make the plant at least quadripinnatifid.

This plant must have had magnificent proportions. Portions of pinnæ seen indicate that those parts of the plant containing them were over half a meter wide and more than a meter in length. This fern shows affinities with several previously described plants. Professor Newberry's *Alethopteris Whitneyi*, obtained from Los Bronces, Sonora, figures of which are given in plate vii of Captain Macomb's report of his "Expedition in New Mexico and Utah," closely resembles our plant. His *Pecopteris falcatus*, obtained from the same locality, and figured in plate vi, fig. 3, is much like some of the fructified forms of *Asterocarpus Virginiensis*. Emmons's *Pecopteris falcatus*, obtained from the Mesozoic of North Carolina, has a certain resemblance to it. *Alethopteris Indica*, from the Rajmahal Hills of India, as described and figured by Oldham and Morris, and also by Feistmantel, is much like our plant. It does not seem to be identical with any of these plants, but is nearest to Newberry's plant and to the Indian plant of those mentioned above. Our plant is probably the one that Professor Rogers, in his paper on the "Age of the Coal Rocks of Eastern Virginia," compares with *Pecopteris Münsterianus* of Sternberg, from Bullenreuth, which is, however, a Woodwardites, according to Schimper. Heer's plant *Merianopteris augusta*, obtained from the Lettenkohle of Neue Welt, is much like *Asterocarpus Virginiensis* in most points, except the fructification. The figure given by Heer, in his "Pflanzen der Trias," plate xxxvii, fig. 1, of a large specimen of *Merianopteris augusta*, is almost a fac-simile of the pinnatifid pinnæ of the lower part of *Asterocarpus Virginiensis*. Heer's plant, however, lacks the large simple pinnules found in the Virginia fossil, and the fructification is quite different. In the fossil from Neue Welt the sori are rounded, simple, and placed between the strong, simple lateral nerves.

Bunbury gives in the Quarterly Journal of the Geological Society, vol. iii, pl. ii, fig. 2, a representation of what he calls *Filicites fimbriatus*, found at Deep Run, Virginia. It is clearly an imperfect specimen of the fructified form of this plant, and is much like the impression that the plant represented in Plate XXIII, Fig. 2, might leave on a rock if imperfectly preserved.

Formation and locality.—Asterocarpus Virginiensis is quite widely distributed, but is not very abundant at any locality. It is found in the strata, usually argillaceous, flaggy sandstones, overlying the lower coal seam at Clover Hill, Carbon Hill, Midlothian, and at Manakin in the beds pierced by the Aspinwall Shaft.

Asterocarpus Virginiensis, var. obtusiloba.

Plate XXI, Figs. 3, 4; Plate XXIV, Figs. 3-5; Plate XXV, Fig. 1.

Frond tripinnatifid, perhaps arborescent. Fertile form not seen. Sterile pinnæ of ultimate order linear-lanceolate, sometimes very long, with stout, rigid rachises, alternate, going off at an angle of about 45°, and slightly curved upwards. Lobes, or united pinnules, alternate, united by one-third their length, and more, very thick and coriaceous, broadly oval, with very blunt and rounded terminations, very slightly curved forwards. Nerves very distinct, sharply defined, usually strong and prominent. Midrib inserted below the middle of the pinnule or lobe, stout at base, dissolved towards the summit into branches. Lateral nerves somewhat various. In all cases some depart from the principal rachis and curve at first outwards and towards their extremities, often upwards, meeting but not uniting with the similarly placed lateral nerves of the adjoining pinnules. Lateral nerves from the midrib going off obliquely, and forked from the base either once or twice, those forking twice being in the lower part of the pinnules; usually strong, but sometimes slender and so much crowded that the long, slender branches are so closely approximated as to appear single.

This plant has a constant facies of its own, and being found only at Clover Hill, it might perhaps with propriety be separated as a distinct species. As, however, the general character is similar to that of *Asterocarpus Virginiensis*, and as this plant is quite variable, I have thought it best to unite the two. The points of difference, however, are quite numerous. The ultimate pinnæ are not opposite, or subopposite, as in *A. Virginiensis*, the lobes or united pinnules are broader, blunter, and united more uniformly to about half-way their length, and no single or simple large pinnules are ever seen. These simple large pinnules are the most common forms of the normal *A. Virginiensis*. The variety now in question appears only at Clover Hill, where it occurs with the normal *A. Virginiensis*, from which it is easily distinguished. The form represented in Plate XXV, Fig. 1, if seen alone, would be entitled to rank as a distinct species, but when it is taken in connection with the forms given in Plate XXIV, Figs. 3, 4, the separation from the normal *A. Virginiensis* is not easily made. The form given in Plate XXV, Fig. 1, presents some peculiarities. The nerves here are very much crowded, slender, and sharply defined. The lateral nerves fork at their insertion, and the long, thread-like branches are so closely crowded together that, without the help of a lens, they often appear to be single nerves. This nervation is shown in the magnified pinnules given in Fig. 1*a*, which represents two pinnules of Fig. 1. Plate XXIV, Fig. 3, represents a compound pinna of the more common kind, and Fig. 3*a* gives enlarged pinnules of the same. Figs. 4, 5 represent portions of two very long ultimate pinnæ, perhaps from lower down on a compound pinna, like that in Fig. 3. Fig. 5*a* is a magnified pinnule of Fig. 5, and Fig. 4*a* a magnified pinnule of Fig. 4. Plate XXI, Fig. 4, represents the upper portion of a compound pinna corresponding to that represented in Plate XXIV, Fig. 3; and Plate XXI, Fig. 3, gives the extremity (magnified) of an ultimate pinna of the same.

Formation and locality.—The plant is found only at Clover Hill, in shales associated with the highest of the series of small coal seams, above the main seam.

Asterocarpus platyrachis, spec. nov.

Plate XXV, Figs. 2–6; Plate XXVI, Fig. 1.

Frond bi- or tripinnate, perhaps arborescent. Principal rachis rigid and stout, one centimeter and more in diameter. Ultimate pinnæ alternate or subopposite, with a broad flat rachis. Sterile and fertile pinnules different, sterile pinnules ovate oblong, bluntly rounded at the extremities and slightly falcate, united for some distance above the bases. Nervation Pecopteris-like, midrib strong and distinct to near the end, and then splitting into branches. Lateral nerves very distinct, going off obliquely, forking near the midrib, the two branches diverging slowly, and continuing nearly parallel to one another until they meet the margin of the pinnule. Pinnæ of the uppermost part of the primary pinna or frond, passing through lobed pinnæ into simple pinnules. These latter near the summit of the frond are much reduced in size, and are united more and more, reproducing the form of the pinnules of the lower part of the frond. Fertile pinnules, without lateral nerves, having a stout rigid midrib, with large sori placed on the margin of the pinnules, and covering most of their surface, forming a row on each side of the midrib, and each row gradually approaching the other towards the summit of the pinnules, forming thus a pinnule elongate-triangular in shape. More rarely fertile and sterile pinnules occur together on the same pinna. The sori are formed of four or five sporangia, which usually appear to be consolidated at their bases, but at their summits are separate and grouped radially around a central point.

The sori are very large and prominent, placed on the margin of the narrowed fertile pinnules, and occupy most of their surface. The two rows approach each other towards the summit of the pinnules, and are capped at the tip of the pinnule with a single sorus. These fertile pinnules have a peculiar rigid aspect, and this, with their sharp triangular form and their oblique insertion, distinguishes them from the fertile pinnules of *Mertensides bullatus*, which, when fully fructified, somewhat resemble them. Seen under a strong lens the sori more commonly present the form given in Plate XXV, Fig. 3 *b*, but they sometimes appear as given in Fig. 3 *c* composed of 4 sporangia rather remotely placed and grouped around an axis. The form given in Fig. 3*b* somewhat resembles the dehiscence of Cyathea, but there is no doubt that the sorus is compound. The specimen depicted in Plate XXV, Fig. 3, in part, was a very large fragment of what seems to have been a compound pinna of some large frond. Only a portion of the specimen is figured. It is 25 centimeters long and 13 wide. This width and length are much below the former dimensions of the specimen, for much of the length of the ultimate pinnæ had been lost from breaking, and a large portion is wanting from both ends of the primary pinna or frond. Plate XXVI, Fig. 1, represents what seems to be a portion from the upper part of the fertile plant. Plate XXV, Figs. 2, 4, and 6, represent portions of the sterile frond, and Fig. 5 gives a somewhat abnormal form, containing on the same pinna both fertile and sterile pinnules. Plate XXV, Fig. 6, gives what appears to be the upper part of a sterile compound pinna where the pinnæ are reduced to pinnules. Fig. 4*a* gives enlarged leaflets of Fig. 4 to show the nervation. The fertile pinnules of this plant resemble somewhat Germar's *Pecopteris truncata*, now considered as an *Asterocarpus*. Our plant is, of all previously described plants, nearest to Heer's *Asterocarpus Meriani*, found in the Keuper of Switzerland. It differs from this plant in the stouter midrib of the sterile and fertile pinnules, in the acute fertile pinnules, in the larger sori, which are placed on the margin of the pinnules and not within the laminæ, as in Heer's plant, and in the number of the sporangia, which are often five, while Heer's plant contains only four, and also in the much greater size of the rachis of the ultimate pinnæ.

Formation and locality.—The plant is found only at Clover Hill, in strata associated with the main coal seam.

Asterocarpus penticarpa, spec. nov.

Plate XXVI, Fig. 2.

Frond bipinnate. Fertile frond alone seen. Rachis of the ultimate pinnæ stout and rigid. Pinnules reduced to groups of sori, which have in their grouping a triangular outline. The sori form two rows, one on each side of the midrib, which is not distinctly seen, containing in each two sori, the two rows being capped by a single sorus, giving five in all. The groups stand at right angles to the rachis. The last sori next to the rachis of the pinna are larger than the rest. The sori are rounded and prominent, with a depression in the center. Further details could not be made out.

This small plant was found only in a very fragmentary condition, and on a rock too coarse-grained to permit the structure of the sori to be made out. The sori are quite large and prominent, showing a slight depression in the center, which sometimes presents an appearance like the indusium of Aspidium. The two lower sori are considerably larger than the rest, and the groups which represent fructified pinnules stand at right angles with the rachis. From the large size and the convex shape of the sori, and the depression in the center of each, they appear to belong to a species of Asterocarpus, and the groups of sori are not unlike *Asterocarpus Sternbergii*, Goepp., from the Carboniferous formation, as figured by Schimper in "Pal. Vég.," plate xli, fig. 15. *A. Sternbergii* has, however, more numerous sori, and the groups are oblong in shape.

Formation and locality.—Found only at Clover Hill, in strata associated with the main coal.

PECOPTERIS, Brongt.

Pecopteris rarinervis, spec. nov.

Plate XXVI, Figs. 3, 4.

Frond bipinnate ? Pinnæ of the ultimate order, with a stout, rigid rachis. Pinnules oblong, subfalcate, separate to the base, opposite, bluntly rounded at the extremities, united more and more towards the end of the ultimate pinnæ, and finally at the ends coalescing into a single undulate terminal pinnule. Nervation Pecopteris-like. Midrib strong to near the apex of the pinnule, sending off at regular intervals lateral nerves, which are quite remotely placed, forked near the middle of their length, and maintain a nearly parallel position to each other.

This small plant was seen only in a very fragmentary condition, and consequently its true place cannot be definitely fixed. It is so much like some of the Pecopterids of the Carboniferous formation that at one time I thought that specimens of it must have really come from that horizon, and have by mistake been placed with the plants from the Mesozoic. There is no doubt, however, that it is a Mesozoic plant. It is a good deal like Heer's *Asterocarpus Meriani*, and also resembles *A. platyrachis*, but the fact that the pinnules are always separate to their bases, except at the ends of the ultimate pinnæ, will distinguish this plant.

Formation and locality.—Found at Manakin, in the material taken out of the Aspinwall Shaft, and at Carbon Hill, in the strata over the bottom coal seam.

CLADOPHLEBIS, Saporta.

Cladophlebis subfalcata, spec. nov.

Plate XXIX, Fig. 5.

Frond bi- or tripinnate. Principal rachis stout and rigid. Ultimate pinnæ linear-lanceolate in shape, alternate, and going off nearly at a right angle from the principal rachis. Pinnules alternate, separate to the base, inclined forward, oblong-ovate, and subfalcate, rather thin and delicate in texture. Middle nerve strong at base, and dissolving into branches toward the end. Lateral nerves going off obliquely, the lower forking twice, the upper once forked, or one of the branches forking a second time. Nerves sharply defined but slender.

This plant is, I think, identical with none that have been previously described. It is something like *Asplenites Rösserti*, Schenk, from the Rhætic of Germany, but is a smaller and more delicate plant, and has the lateral nerves more frequently branched. It also resembles *Mertensides bullatus*, but differs in the absence of the spatulate pinnules, and in the forward inclination of the pinnules.

It is strikingly like the plant described by Feistmantel in the "Palæontologia Indica," series xi, 2, as found in the Upper Gondwana Group of India, in the Satpura Basin, and figured on Plate II, Figs. 2–7. The only difference is that the plant from India has a smaller rachis, and the pinnules are more often united at base. Feistmantel considers this plant as identical with *Alethopteris Whitbiensis.* I think this identification doubtful, and would rather consider it as near to *Asplenites Rösserti*, if it is not a new species.

Formation and locality.—Found only at Manakin, in the material from the Aspinwall Shaft. Exact horizon not known.

Cladophlebis auriculata, spec. nov.

Plate XXVI, Figs. 6, 7.

Frond bi- or tripinnatifid, with a strong, ridged rachis, the ridge swollen at the insertion of the ultimate pinnæ. Ultimate pinnæ subopposite, going off at nearly a right angle, very long, slender, and linear in shape, having a rachis corded on each side, causing a groove in its center. Pinnules thick and coriaceous in texture, opposite or alternate, united at the lower part of the base. The base is abruptly expanded into an auricle on each side, giving the pinnules a broadly ovate form. Nervation not very distinctly shown, but apparently as follows: Midrib stout at base, slender above the middle, and splitting up into branches. Lower lateral nerves branching several times, the number of branches diminishing in the upper lateral nerves, until they only branch once.

This is a very well-marked plant. The pinnules must have been very thick and leathery, for they leave deep impressions in the shale. The pinnæ of ultimate order are very long and slender, and are inserted nearly at right angles to the principal rachis. This latter seems to belong to a primary pinna. It is strongly ridged, the ridge being expanded to receive the bases of the ultimate rachises. These latter have on each side a cord-like ridge, to which the bases of the pinnules are attached, and a shallow, flat, central depression. The pinnules are normally united only at the lowest part of their bases, but toward the ends of the ultimate pinnæ become more and more united until they pass into a terminal portion, which is merely undulate on the margin. Their broad, auriculate base is the most characteristic feature. The nervation, owing to the thick and dense nature of the leaf-substance of the pinnules, is not well disclosed, but appears to be as shown in Plate XXVI, Fig. 6*a*, which represents an enlarged pinnule of Fig. 6. Plate XXVI, Fig. 7, represents a somewhat abnormal form of the terminal portion of an ultimate pinna, in which the pinnules are more crowded than in the normal form given in Fig. 6.

Formation and locality.—Found only at Carbon Hill, in the flaggy sandstones over the lower coal seam, along with *Acrostichides rhombifolius.*

Cladophlebis ovata, spec. nov.

Plate XXVI, Fig. 5; Plate XXVII, Fig. 3.

Frond bi- or tripinnate. Principal rachis strong, rigid, with a flat groove on one face and a strong, raised central portion on the other. Ultimate pinnæ alternate, linear in outline, with strong, rigid rachises. Pinnules alternate, dense, and thick in consistency, ovate, obtuse, and slightly falcate, separate to the base. Nerves not well shown, being slender, and immersed in the thick leaf-substance of the pinnules, but apparently as follows: Midrib slender, and dissolving into branches at the summit. Lateral nerves delicate, the lowest twice forked, the upper once forked.

This plant had a very strong principal rachis. The specimen represented in Plate XXVI, Fig. 5, seems to be a fragment of a very long primary pinna rather than frond. The rachises of the ultimate pinnæ are also very stout and rigid in comparison with the size of the pinnules. The plant may well have been arborescent. The pinnules must have been of a thick and leather-like consistency, for they leave a considerable film of coal on the rock and cause a distinct depression in it. They are, as is usual with thick pinnules, when found on soft shale, convex on the upper surface to some extent. The nerves being slender, and immersed in the substance of the pinnules, cannot be seen with distinctness. They appear as given in Fig 5 *a*, which represents enlarged pinnules of Fig. 5. Plate XXVII, Fig. 3, represents a specimen which shows a face of the principal rachis the opposite of that seen in Plate XXVI, Fig. 5. The plant seems to have had on one face of the principal rachis, perhaps the upper one, a depression or channel, and on the opposite face a strong ridge corresponding to the channel on the other side. I know of no previously described plant with which this could be identified, or indeed which closely resembles it.

Formation and locality.—Found only at Clover Hill, in strata probably connected with the upper series of small coal seams, and here very rare.

Cladophlebis microphylla, spec. nov.

Plate XXVII, Fig. 2.

Frond bi- or tripinnatifid. Principal rachis slender, ridged on one side. Ultimate pinnæ alternate, long, slender, and linear-lanceolate. Pinnules united at the lowest part of the base, subquadrate and falcate, rather thick in consistency, and alternate. Nerves very distinct and prominent. Middle nerve stout at base, and splitting up into branches about midway the length of the pinnule. Lateral nerves all once forked from near their insertions.

The nervation of this plant in its tendency to flabellate divergence approaches that of the Acrostichides species, which have a rhombic or subquadrate shape in the pinnules. In the shape of the pinnules this plant resembles them, but the nervation is less complex, the branching of the lateral nerves being less copious. The shape of the pinnules is also somewhat like that of the pinnules of *Cladophlebis ovata*, but the nerves of this plant are not immersed in the leaf-substance of the pinnules as those of *C. ovata* are, and they are very distinct. At the same time the pinnules are united at base and more subquadrate in shape than those of *C. ovata.* The plant seems to have been more delicate also than *C. ovata.*

Cladophlebis microphylla is a good deal like *Alethopteris Mexicana*, Newb, found at Los Bronces, Sonora, and described by Dr. Newberry in the report of Macomb before mentioned. The pinnules of *A. Mexicana* are more pointed and slender than those of *Cladophlebis microphylla.*

Formation and locality.—Found at Clover Hill only, in strata perhaps connected with the upper series of small coal seams. Very rare.

Cladophlebis pseudowhitbiensis, spec. nov.

Plate XXVII, Fig. 4.

Frond bi- or tripinnate. Principal rachis thick and woody. Ultimate pinnæ alternate, with a rather strong rachis, corded on each side at the insertion of the pinnules. Pinnules ovate-falcate, acute, separate to the base, and alternate. Nerves not well shown, but apparently as follows: Middle nerves stout at base, and splitting into branches at the summit. Lower lateral nerves twice forked, upper ones forked once, with the upper branch forking again.

This pretty little plant has its nerves immersed in the leaf-substance of the pinnules, and hence they are not well disclosed. They appear to be as shown in Plate XXVII, Fig. 4*a*, which is an enlarged pinnule of Fig. 4. This latter represents what appears to be a portion of a primary pinna which must have had considerable dimensions. It is more like *Pecopteris Whitbiensis* of the English Oölite than any of the Cladophlebis forms of the Richmond Coal Field, but is evidently not identical with it, unless we follow the custom of some authors who put all plants of this type from the Jurassic, in the species whose type is *Pecopteris Whitbiensis.*

Formation and locality.—Found only at Clover Hill, in strata above the main coal seam, and probably associated with the upper series of small coal seams.

Cladophlebis rotundiloba, spec. nov.?

Plate XXVII, Fig. 1.

Frond? Ultimate pinnæ with rounded lobes, which have only their summits free. Nerves slender. Middle nerve branching in a flabellate manner, the branches once forked, and curving up to meet the upper margin of the lobes. Lateral or secondary nerves going off mostly from the rachis of the pinnæ, and curving up toward the upper part of the lobes.

This small fragment has somewhat the appearance of a Goniopteris, so far as the nervation goes, with the exception of the forking of the lateral nerves, but as the portion seen is evidently a fragment of a lobed pinna or pinnule, and gives but a faint idea of the true character of the plant, I place it provisionally in the genus Cladophlebis, to which its nervation would seem to refer it. It may be identical with *Asterocarpus Virginiensis*, var. *obtusilobus*, though found at a locality remote from that where this plant occurs. It is one of the few plants found in the Hanover Area, the northern portion of the Richmond Coal Field.

Formation and locality.—Hanover County, near Hanover Junction, in the upper barren strata of the Mesozoic of this portion of the field.

LONCHOPTERIS, Brongt.

Lonchopteris Virginiensis, spec. nov.

Plate XXVIII, Figs. 1, 2; Plate XXIX, Figs. 1–4.

Frond bi- or tripinnate. Ultimate pinnæ alternate or subopposite. United pinnules or lobes closely crowded, opposite or subopposite, united at base, becoming more and more united towards the summit of the frond, or primary pinna, and with the pinnæ finally passing into simple pinnules. Basal pinnules or lobes placed close to the principal rachis, so as to make the ultimate pinnæ sessile. The pinnules are various in shape, either oblong, slightly falcate, and very obtuse, or ovate, slightly falcate, and somewhat acute. Middle nerve strong at base and dissolved above the middle of the pinnule into a network of branches. Lateral nerves departing both from the middle nerve and the rachis of the ultimate pinnæ, usually branching once before anastomosing, the branches repeatedly anastomosing, and often free at the margin of the pinnules or lobes. The anastomosis forms elongate elliptical meshes, which have their longer axes turned out towards the margin of the pinnules. The nerves are very strong.

This splendid plant must have been a very large fern, for the fragment given in Plate XXVIII, Fig. 1, is plainly only a small part of a primary pinna or frond, and one coming from the summit. It shows clearly the gradually increased union of the lobes or pinnules, until they finally pass into simple pinnules. Plate XXIX, Fig. 1, seems to represent a portion of the lower part of the plant, where the lobes or united pinnules are very obtuse. Fig. 4 represents a portion of the plant where the lobes are still broader and more obtuse, while they are united higher up than in Fig. 1. Fig. 2 gives another form of lobes, and Fig. 3 still another. The plant must have been rather variable in the shape of the lobes and in the amount of their union. The middle nerve is quite distinct and strong toward the base of the lobes, but disappears above the middle of these. The lateral nerves, which by their anastomosis form the network of veins which fills the lamina of the lobe, are very strong and sharply defined, so that they are distinctly visible even on rather coarse-grained sandstones. The elongate meshes often, owing to the compression to which the specimens have been subjected in the rock, appear convex and cause the lobes to appear mamillated. This plant resembles more closely than any others the Lonchopterids of the Carboniferous formation. It resembles *Lonchopteris rugosa*, Brongt., from Anzin, France, and *Lonchopteris Röhlii*, Andr., from near Aix-la-Chapelle. It has some resemblance, except in the details of the nervation, to Emmons's *Acrostichites oblongus*, Am. Geol., plate 4, fig. 8.

Formation and locality.—Found at Manakin, in the material taken out of the Aspinwall Shaft, and at Clover Hill. From this last locality the specimens figured in Plates XXVII and XXIX were obtained. Occurs here only in a siliceous sandstone of gray color with Clathropteris, and other plants not found in any other beds below the main coal seam. The horizon is probably that between the bottom and main seam.

CLATHROPTERIS, Brongt.

Clathropteris platyphylla, var. expansa, Saporta.

Plate XXXI, Figs. 3 and 4; Plate XXXII, Fig. 1; Plate XXXIII, Fig. 1; Plate XXXIV, Fig. 1; Plate XXXV, Fig. 2.

Frond digitately pinnatifid. Primary segments or lobes, at least six, united at base, and diverging in a palmate manner, oblong, 30 centimeters and more long, average width 8 to 10 centimeters, extreme width 20 centimeters, with broad, shallow crenate teeth along the margins. Primary nerves, or rachises of the segments, very strong and prominent, the central ones single, the outer one on each side sending off branches outwardly. These branches, and the central unbranched rachises, pass one into each segment, forming its midrib. Secondary nerves, or lateral nerves of the segments, in the united portions of the segments, rather slender, and going off under an acute angle, those of the free portion of the segments, strong, rigid, prominent, going off nearly or quite at a right angle, curving upward towards the ends of the lobes or segments, and directed into the teeth along the margin, but ceasing before reaching the tips of the teeth, parallel to each other throughout their entire course. Tertiary nerves strong and prominent, going off from the secondary nerves at a right angle, and parallel to each other. Each tertiary nerve meets one proceeding in a similar manner from the adjoining secondary nerve, about midway between the two secondary nerves, and unites with it, producing at the place of junction a slight departure from a straight line. The united tertiary nerves divide the space between the secondary nerves into parallelograms. The tertiary nerves in turn send off branches nearly at a right angle, which anastamose with each other, and with similar ones coming off from the secondary nerves, and thus fill the rectangular parallelograms with quadrilateral or polygonal meshes. Further subdivision of the nerves could not be made out.

As this plant was found only in a siliceous sandstone, the nervation could not be pursued further than the branches of the tertiary nerves, and these could be made out only in exceptionally well-preserved specimens. The plant must have been a very large one, and could not have been in the larger specimens less than 60 centimeters in length, measured from the junction of the rachises of the segments to the tips of the segments, while the expanse laterally of the frond was probably greater. The rachises of the segments must have been very rigid and prominent, for in many cases they leave deep furrows caused by their imprint in the firm siliceous sandstone. Plate XXXV, Fig. 2, represents a fragment of an abnormally large segment. In this the margins do not show the teeth, hence they are not preserved, but the attenuation of the secondary nerves shows that the width of the fragment very nearly represents the entire width of the segment of which it forms a part. Plate XXXI, Fig. 4, gives the average width of the more common specimens of the full-grown plant. On this segment three teeth are to be seen on the right-hand border, and one on the left-hand border. Plate XXXI, Fig. 3, gives a fragment of a somewhat smaller lobe or segment, in which the tertiary nerves are beautifully shown, dividing the spaces between the secondary nerves into very regular parallelograms. Specimens without teeth were seen 20 centimeters long, such as is shown in Plate XXXII, Fig. 1. Plate XXXV, Fig. 2 *a*, gives a magnified portion of Fig. 2 to show the details of the nervation, so far as they could be made out. The stone was too coarse to allow the ultimate reticulation to be seen. Plate XXXIV, Fig. 1, shows a portion of the united segments representing three segments. From this some idea may be obtained of the great expanse of the frond. On this specimen traces of the secondary nervation may be seen, and its slenderness and oblique nature in the united parts may be discovered. In Plate XXXIII, Fig. 1, we have fragments of three central primary rachises, and one outer one on the left-hand side. This outer one is seen to send off two branches, directed outwards into the left-hand border of the frond. It is much stronger than the central rachises. The inner one next to this branching rachis, has its base closely pressed against the base of the outer rachis in a manner which might, to the casual observer, suggest that the two branch from this point. The close approximation results from a crush which has affected the lower portion of this fragment. The union of this inner rachis and the branching outer one takes place lower down, in a portion of the frond not visible in the specimen. The entire fragment given in Plate XXXIII, Fig. 1, seems to belong to the united portion of the lobes, and, if so, this part of the frond must have had very considerable dimensions.

It will be seen from this account of the plant that it differs in several points from the normal *Clathropteris platyphylla* as found in Europe, and described by Schenk, Schimper, and others. But in all the points in which it differs from the normal form, it approaches the variety *expansa*, described by Saporta in "Plantes jurass.," and figured on Plate XXXVIII, Figs. 3, 4; Plate XXXIX, Fig. 1; Plate XL, Fig. 1. Saporta's plant is from the Infra-Lias, near Autun, France. The French plant has the same characters as the Virginia one. We find in it the same prominent rigid rachises of the segments. The secondary nerves go off nearly or quite at a right angle, and curve up towards the summit of the segments. The character of the teeth is exactly the same with that of the Virginia plant. Saporta says that the plant he describes is larger than the normal German *C. platyphylla.* The average size of the Virginia plant is the same with that of the French one. But the largest specimen of the Virginia fossil is considerably larger than any of the specimens given by Saporta. In Saporta's plant the secondary nerves terminate in the tips of the teeth, on the margin of the segments, while they appear to terminate in the Virginia fossil before reaching the extremity of the teeth. The ultimate nervation of the French plant in some specimens seems to be rather more irregular than that of the Virginia fossil. Still the points of resemblance are too great to permit the two to be separated, and I think that there is no doubt that the two plants are specifically the same, with only such differences as should be expected in localities so widely separated.

Mr. E. Hitchcock has described in the "American Journal of Science" for July, 1855, a species of Clathropteris found in the Connecticut Valley sandstone, which he calls *Clathropteris rectiusculus*. This in many points is much like the normal *C. platyphylla* of Europe, and it is also something like the Virginia plant. He gives a figure of three segments, isolated from each other, but in such a position that they may well radiate from a common point. Dana gives a figure of one of these lobes or segments on page 407 of his "Manual of Geology," revised edition. This plant seems to be smaller than the Virginia fossil, and it has more delicate nerves. It can hardly, I think, be separated from the normal *C. platyphylla*. Hitchcock says that it is found at Easthampton, Mass., at an horizon about midway between the base and summit of the Connecticut sandstones of Mesozoic age. In his description he speaks of it as profoundly pinnatifid, and seems to have had in mind the pinnatifid character of *C. meniscioides* which, as is well known, is pinnately, not digitately, lobed.

From statements made concerning other specimens found at this locality it would appear that the Easthampton plant is digitately lobed. Mr. Hitchcock states that he presented to the cabinet of Amherst College a large specimen from Easthampton, showing in one place a large number of lobes or segments radiating from a central point. It may well be, however, that some of the fossils found in the Connecticut sandstones are Dictyophyllum or Camptopteris, and not Clathropteris. Dictyophyllum, as Schenk shows, has numerous segments proceeding from two principal divisions of the rachis at its base, while the divisions of Clathropteris are much more limited in number. The nervation of Dictyophyllum also is near enough to that of Clathropteris to cause, in poorly-preserved specimens, the two to be confounded. We must then be cautious in deciding that all the digitately-divided, reticulated ferns from the Connecticut sandstones are Clathropteris. Hitchcock states that in the cabinet of Amherst College is a fine specimen of a radiating Clathropteris from Gill, Mass., which shows seventeen distinct segments radiating from one stem. This can hardly be anything but a Dictyophyllum or Camptopteris. It cannot be *Clathropteris platyphylla.*

In the same cabinet is another obscure specimen of Clathropteris from the banks of the Connecticut River, in Montague, Mass. From this it would appear that plants of the general character of Clathropteris are not uncommon in the Mesozoic sandstones of the Connecticut Valley, and also that some of them may be Dictyophyllum or Camptopteris.

Professor Newberry gives a figure of a plant with twenty or more segments radiating from a common center on plate vii, figs. 2, 2*a*, in Macomb's "Report of the Exploring Expedition from Santa Fé." It was obtained from Los Bronces, Sonora, and is described under the name *Camptopteris Remondi.* It seems to be a true Camptopteris, and is very different from our Virginia plant, while it may be very close to Hitchcock's plant showing seventeen segments. The resemblance between the plant from the Connecticut River Mesozoic and the Virginia fossil is sufficiently close to suggest that the horizon of both may be the same; but additional fossils from the Connecticut River area of Mesozoic strata will be needed to entitle us to draw any conclusions on this subject.

Formation and locality.—Found only at Clover Hill, in sandstone, with Lonchopteris, under the main coal and above the bottom seam.

PSEUDODANÆOPSIS, gen. nov.

Frond pinnate. Principal rachis stout, prominent, and rigid. Pinnules oblong-lanceolate, or ensiform, alternate or subopposite, attached by the entire width of the expanded base, somewhat decurrent. Middle nerve of the pinnules strong, rigid, prominent, sharply defined, and prolonged to the termination of the pinnules. Lateral nerves distinctly defined, departing from the middle nerve of the pinnules and from the principal rachis on the lower side of the base of the pinnules, branching several times, the branches anastomosing once or several times before reaching the margin of the pinnules. Type: *Pseudodanæopsis reticulata.*

I find myself compelled to place these plants in a distinct genus, as their features are so constantly different from those of all previously described genera that they cannot be well placed in any existing ones. The facies of the plants and many of their details are clearly like those of the genus *Danæopsis* of Heer, and from this resemblance I derive the name for the genus. *Danæopsis marantacea* is described as showing not rarely an anastomosis of the lateral nerves, but this is not the case with the species of Pseudodanæopsis. They have always the secondary nerves anastomosed, and this is clearly no sporadic occurrence. It is one of the most constant and characteristic features of these plants, which, without it, would certainly be species of Danæopsis.

Pseudodanæopsis reticulata, spec. nov.

Plate XXX, Figs. 1–4.

Frond pinnate. Principal rachis rigid, smooth, and stout. Pinnules alternate, more or less expanded at base and decurrent, attached by the entire base, attaining the dimensions of at least 12 centimeters in length and 2½ centimeters in width, oblong, ensiform or lancet-shaped, having the extremities narrowing, with an elliptic outline. Middle nerve of the pinnules cylindrical, strong, and very sharply defined, gradually tapering to the tips of the pinnules. Lateral nerves very slender, but sharply defined, and immersed in the rather thick and coriaceous leaf-substance of the pinnules, going off from the principal rachis on the lower side of the base of the pinnules, and from the middle nerves under an angle of about 45°, branching sometimes near the point of insertion and sometimes only at a considerable distance from the midrib of the pinnules, the branches anastomosing several times and finally emerging free at the margin of the pinnules.

This species has several characters by which it may be recognized at a glance. Its prominent rigid midrib, the thick texture of the pinnules, and their straight, well-defined border cause the pinnules of this plant to leave imprints which cannot be mistaken for those of any other species. The pinnules must have been very easily broken off, for they are usually found detached, as represented in Fig. 2. Detached pinnules and fragments are quite common, but specimens showing the mode of attachment are very rare. I could only find a few, after long and persistent search for them. The pinnules in the lower or middle part of the frond seem to have been attached under rather an open angle, as represented in Fig. 1, while those of the upper part appear more oblique and decurrent, as shown in Fig. 4. The nervation is thin and delicate, though very sharply defined, and it is immersed in the rather dense leaf-substance. Some of the specimens occurring in a fine-grained shale show the minutest details of the nerves with a perfection not surpassed by the finest lithograph. This was the case with the specimen depicted in Fig. 4, the details of the nervation of which are given in Fig. 4*a*, which represents an enlarged portion of the specimen. Fig.

2 is a fragment of what must have been a pinnule at least 12 centimeters long. It is given of natural size. The lateral nerves are inserted at some distance from one another, and branch either near the midrib of the pinnules or some distance from it. The nervation near the midrib is quite distant and lax, but from about half way between the midrib and margin up to near the border of the pinnules, the nerves anastomose frequently, and fill the lamina with a close, fine reticulation. The meshes are elongate and irregular in form. At the margin of the pinnules the nerves become free, and appear simply forked, as shown in Fig. 2. Fig. 3 gives a form of the plant in which the bases of the pinnules appear somewhat rounded. This specimen shows marks of considerable compression, especially at the bases of the pinnules, and I think the rounding off is due to the fact that the leaf-substance has been pressed into the yielding material of the shale. In Fig. 1, I have given a restoration of what I take to be the appearance of the large pinnules when inserted on the principal rachis. No specimen has been seen showing all the details combined that are given in this figure. It is a restoration obtained by taking many specimens and uniting features found in each.

Professor Emmons in "American Geology," fig. 90, depicts a plant under the name *Strangerites planus*, which is evidently the same with *Pseudodanæopsis reticulata*. It has the same shape in the fragment of a pinnule given in the figure, the same rather slender and lax nervation, the same prominent, well-defined midrib, and the same size with *P. reticulata*. Professor Emmons has drawn the nerves of his plant in rather a vague manner, and represents many of the branches of the lateral nerves as stopping short in the lamina of the pinnule, when, if continued, they would anastomose with their neighbors.

Formation and locality.—This plant is quite widely diffused, and is not uncommon at several localities. It has been found at Clover Hill, at Midlothian, and at Carbon Hill. Only at the latter place could the precise horizon be fixed. It occurs here in the shaly sandstones over the lower coal bed, along with *Acrostichides rhombifolius*, *Asterocarpus Virginiensis*, &c.

Pseudodanæopsis nervosa, spec. nov.

Plate XXXI, Figs. 1, 2.

Frond pinnate. Principal rachis strong, prominent, and rigid. Pinnules subopposite, with a strong, rather flat middle nerve, attached by the entire width of the expanded base, slightly decurrent in the middle and lower pinnules, and more so in the upper ones, which are obliquely attached and united at base, while the lower pinnules are remote and separate to the base, and go off under an angle approaching a right angle. Middle nerve tapering gradually to the summit of the pinnules, broad and rather flat. Lateral nerves very strong and distinct, departing both from the midrib and from the principal rachis at the base of the pinnules on the lower side. Those from the midrib go off at an acute angle, and curve strongly outwards to meet the margin of the pinnules. They fork near the midrib or at various distances from it, sometimes not until the margin is nearly reached. Those that fork near the midrib fork again one or more times. All anastomose very regularly near or at the margins of the pinnules.

In this plant also the lateral nerves go off from the midrib at some distance from one another, so that the nervation is rather open. The lateral nerves fork very variously, some fork near the midrib, and these usually fork again one or more times; others do not fork until the middle of the space between the midrib and the margin is reached, and others again fork only near the margin. All anastomose close to and usually on the margin of the pinnules. The nervation is very distinct, for the lateral nerves often appear on the shale when there is no trace of the leaf substance of the plant, and we thus have a skeleton of the nerves. This is seen in Fig. 2, on the right-hand side of the specimen, where the lateral nerves at the bases of the pinnules leave their imprints, while there is no trace of the pinnule itself. It will be noted that this plant is quite close to the normal form of Danæopsis, both in the general character of the frond and in the nervation, which is less freely anastomosed than that of the preceding species. The constant union of the branches of the lateral nerves at the margin of the pinnules is a feature, however, not found in Danæopsis, though occasional anastomosis occurs in it.

Certain forms described by Professor Newberry, from Los Bronces, Sonora, in the report of Captain Macomb, before mentioned, resemble in some respects this plant.

On plate viii, figs. 2, 2*a*, Professor Newberry gives a very large plant, with the aspect of a Tanæopteris, or rather Macrotæniopteris, which he calls *Tæniopteris glossopteroides.* This plant, obtained from the locality at Los Bronces, which yields so many species like our Virginia plants, differs from both of the species of Pseudodanæopsis, chiefly in the much greater size of the pinnules. While the specimens figured may be parts of a simple frond, there is nothing about them except their large size that would forbid the idea that they are pinnules detached from a pinnate frond. The tapering towards the base seen in fig. 2 *a* is due probably to the mode of laceration of the plant. The rounded, rigid, prominent midrib, and the slender, frequently anastomosing lateral nerves which go off under an acute angle and curve outwards towards the margin of the pinnules, seem to indicate a plant allied to *P. reticulata.* But the lateral nerves are more oblique than those of the two Virginia species, and the branches keep more of a parallel course. At the same time the anastomosing nerves are less numerous than in *P. reticulata* and more numerous than in *P. nervosa.* Hence it would appear probable that we have here a plant uniting the characters of nervation of the two Virginia species, with features peculiar to itself. The size of the pinnule to which the fragments belong would be no reason for refusing to place *Tanœopteris glossopteroides* in the genus Pseudodanæopsis, for the fragments do not indicate a pinnule larger than, or indeed as large as the pinnules of the magnificent specimen of *Danœopsis marantacea*, figured by Schimper on plate xxxvii of his "Pal. Vég."

Prof. E. Emmons, in his "American Geology," part vi, gives a description of a plant, fig. 89, which he calls *Strangerites obliquus.* This is probably the same with *Pseudodanœopsis nervosa.* The undulating margin of this plant, and its narrowing towards the base, seem to be due to the imperfect preservation of the specimen. It does not show the anastomosis, it is true, of the lateral nerves at the margin of the pinnule, since that part is removed in the laceration of the plant. The size of the fragment, the straggling lateral nerves, and the flatness of the midrib, all seem to show that it is very near *P. nervosa.* Professor Emmons has evidently very imperfectly represented the nerves, causing them to stop short in the lamina of the pinnule. If they were continued in the direction held by them where they stop short they would clearly anastomose near the margin.

Formation and locality.—Pseudodanœopsis nervosa is a much rarer plant than *P. reticulata.* It is found only at Clover Hill in a fine-grained dark shale, associated with the upper series of small coal seams. This shale disintegrates rapidly under the action of the weather. It had been exposed on the "dump" for some time when I saw it, and had mostly crumbled away. From this cause I was enabled to find only a few specimens.

SAGENOPTERIS, Presl.

Sagenopteris rhoifolia?

Plate XXX, Fig. 5.

Only a small fragment of this plant was found, but enough to show that it is clearly a Sagenopteris. Only the basal portion was seen. The nerves are fine, but sharply distinct, and anastomose frequently. It resembles strongly the common Sagenopteris of the Rhætic of Europe, viz., *S. rhoifolia.* It is, I think, identical with Emmons's *Cyclopteris obscurus* from the Mesozoic of North Carolina (see Emmons's "American Geology," plate 4, fig. 10). It has been found only at Clover Hill.

DICRANOPTERIS, Schenk.

Dicranopteris, spec.?

Plate XXX, Fig. 6.

Only a fragment of this plant was found, showing rather remotely placed and forking nerves, going off obliquely from a principal nerve. The specimen seems to be a portion of a large flabellate leaf, like the *Dicranopteris Römeriana* of Schenk, a figure of which he gives on plate xxi of the "Flor. der Grenzschichten." Only the nerves which go off on one side of the principal nerve appear. The plant was evidently a large one. It has been found at Clover Hill âlone. A single specimen only was obtained, and it does not show enough to fix with certainty the species.

GYMNOSPERMÆ.

ZAMIEÆ.

PTEROPHYLLUM, Brongt.

Leaves with pedicel, linear-elongate, suddenly narrowed towards the base and apex; leaflets perpendicular to the sides of the midrib and attached by their whole

base, unequal in length, separate to the base, and exactly linear, not contracted at base, rotundate-truncate at the extremities. Nerves parallel to the margin of the pinnæ and to one another and simple.

The plants of this genus are few, both in species and individuals, in the Mesozoic beds of Virginia. The number of individuals is especially small, and this suggests the idea that the genus is in process of decadence. This statement applies to the true Pterophyllum plants with the generic character above given, and of the type of *Pterophyllum longifolium*, Brongt.

Pterophyllum inæquale, spec. nov.

Plate XXXVI, Fig. 1.

Leaf elliptical in outline, midrib strong, with a raised line, or cord, in the middle, tapering very gradually to the summit. Leaflets standing at right angles to the stem, and united at their lowest portions next to the midrib by a slight expansion of their bases. From the point of union to their summits they are of equal width, and at the summit are rounded off into an elliptical or rotundate-truncate tip, which is always bluntly ended. Leaflets of the middle portion of the leaf longest, attaining an extreme length of 5½ centimeters, gradually shortening from the central portions towards the base and summit of the leaf, and some distance from the summit suddenly diminishing in length, and then from this point gradually again shortening. They vary in width, narrow and wide leaflets occurring in an irregular manner. The widest are 7 millimeters, and the narrowest 3 millimeters wide. Nerves strong and distinctly defined, forking immediately at their emergence from the midrib, and from that point simple, parallel to one another and to the margin of the leaflets. Nerves of the middle and lower leaflets go off from the midrib differently from those of the upper leaflets. In the former the middle nerves of the leaflets go off at right angles to the midrib, and maintain this direction to the end of the leaflets. Those near the upper and lower margins of the leaflets go off somewhat obliquely, and arch away from the midrib to assume a position parallel to the central nerves. Nerves of the upper leaflets all go off obliquely, and curve strongly away from the midrib, assuming a position parallel to one another in entering the leaflet.

The upper and lower parts of this plant were not seen, as the most complete specimen, the one figured, was lacking in these parts. Only this specimen and a small fragment of another were found. The plant has several features which are quite characteristic. The peculiar sudden abbreviation of the leaflets towards the summit of the leaf, and the intermingling of leaflets of different widths in an irregular manner, are seen in no other Petrophyllum known to me. The midrib seems to have been fleshy and covered with a thick, dense epidermis. The elliptical outline of the leaf differs from that of all other species of Pterophyllum of this type, for they are suddenly narrowed at the extremities and have an oblong form. The branching of the nerves at their insertion is another peculiar feature. The obliquity of the insertion of the outside nerves, and the perpendicular position of the central ones of the lower leaflets, are features seen in the nervation of *Ctenophyllum Braunianum*, and also in the *Pterophyllum æquale* of Nathorst, as given by him in his "Floran vid Bjuf," plate xv, fig. 6 *a;* indeed, the Virginia plant, notwithstanding the contradiction in the names, is strikingly like this plant from the Rhætic of Sweden. Fig. 11 of this plate gives a representation of the plant which is very much like the Virginia fossil. We find in the Swedish plant the same shape and size of the leaflets; they terminate in the same blunt extremities, and the nervation is the same. The midrib of the Swedish plant has also a raised line, or cord, in the middle. The leaflets given by Nathorst are more uniform in width than those of the Virginia plant, but some of the specimens have narrow leaflets, and others wider ones, just like those of the Virginia fossil, however, they are on distinct fragments in the Swedish Pterophyllum. Another fossil which is very near the Virginia plant now in question is *Pterophyllum longifolium*, Andrae, from the lower Lias of Steirdorf. It shows the same peculiarity of having narrow and wide leaflets intermingled. *Pterophyllum longifolium*, which is Schimper's *P. Jägeri* of the Trias, Emmons's *Pterozamites decussatus*, Andrae's plant, and the Virginia fossil, *P. inæquale*, all seem to be closely allied, and perhaps are the same species, modified only by differences of geological age and of locality.

Our plant is, as above intimated, a good deal like *Pterophyllum longifolium*, Brongt., as described by Heer in his "Pflanzen der Trias," and figured on plate xxxiii, fig. 1. Heer's plant, however, has a very different termination for the leaf; the leaflets are regularly of the same width, the nervation is all perpendicular to the midrib, and the nerves are not branched at their insertion.

The Virginia plant has some resemblance to Emmons's *Pterozamites decussatus*, "Am. Geol.," plate 3, fig. 1.

Formation and locality.—Found only in two specimens, both on the same slab, at Clover Hill, in strata associated with the upper series of small coal seams.

Pterophyllum affine, Nathorst.

Plate XXII, Figs. 2-4.

Leaf with a strong, rigid midrib; leaflets going off at right angles from the midrib, closely placed, of exactly the same width from base to summit, separate to the base, truncate, or with a summit obliquely cut, so that the upper edge of the leaflet is longer than the lower. Extreme length of the leaflets 3 centimeters; width varying in different specimens, from 8 to 16 millimeters, normal width 10 millimeters. Nerves very fine, closely placed, simple, and at right angles to the midrib.

I have identified this plant with the *Pterophyllum affine* of Nathorst, as described in his "Floran vid Bjuf," and figured on plate xv., figs. 12, 13. The only difference is that the Virginia plant attains larger dimensions in some cases, although fig. 4 gives a specimen with leaflets of the same width as those of the Swedish plant, but with a little greater length. Another unimportant point is that the Swedish plant has its leaflets wider apart than those of the Virginia fossil. Both plants have the same shape in the leaflets, with the same peculiar oblique or truncated terminations, the same mode of insertion, and the same nervation, which is peculiarly fine and closely placed. The Virginia fossil belongs to the same type of Pterophyllum as the *P. propinquum* of Schenk, figured in the "Flora der Grenzsch.," plate xli, fig. 1, and which is given by Feistmantel also on p. 110 of "Pal. Indica," series II, 7, as occurring in the Rajmahal Group of India. It is also not unlike *Pterophyllum Rajmahalense*, Morris, given on plate xiv, of the "Fossil Flora of the Rajmahal Series." *Pterophyllum princeps*, Oldh. & Morris, given in "Pal. Indica," series II, 7, plate xlvii, seems also to belong to this type of Pterophyllum, but these last-mentioned plants are larger than ours. It also resembles closely Newberry's *Pterophyllum delicatulum*, from Sonora. These plants all have a certain resemblance to Anomozamites. The Virginia fossil, however, presents no evidence that it has any of the leaflets of varying width characterizing Anomozamites. It is no doubt a true Pterophyllum of a characteristic Rhætic and Liassic type.

Formation and locality.—Found only at Midlothian, in material taken out of a deep shaft, the precise horizon not being known; only three or four specimens were found, and on the same slab of sandstone.

Pterophyllum decussatum.

Plate XLIII, Fig. 2.

Pterozamites decussatus, Emmons. Am. Geol., plate iii, fig. 1.

The small fragment of this plant figured on Plate XLIII, Fig. 2, was found in the Cumberland Area in the black shale occurring on the horizon of the coal beds. It seems identical with the fossil found by Emmons in the Mesozoic strata of North Carolina, and called by him *Pterozamites decussatus.* The only point of difference is the slight narrowing of the leaflets towards their base and their slight expansion immediately at their base. These are points that serve to unite this plant closely with the *Pterophyllum longifolium* of Andrae, *P. Andrœanum* of Schimper, from the lower Lias of Steirdorf. The chief difference is the smaller size of the leaflets of *P. decussatum.* It is also much like *P. longifolium,* Brgt., from the Trias. The nerves are simple from their insertion, and parallel to one another and to the margin of the leaflets. The middle nerves of the leaflets stand at right angles with the midrib, while the nerves nearer the sides of the leaflets are slightly oblique at their insertion. Only a small portion of the midrib is shown at the base of the leaflets.

CTENOPHYLLUM, Schimper.

Leaves linear; leaflets attached obliquely to the upper side of the midrib, more often opposite, linear, obtuse, decurrent at base, coriaceous, with delicate and parallel nerves.

Schimper has separated all the plants with the above features from the genus Pterophyllum. The true Pterophylla are perhaps more abundant in the Triassic than in any other formation, while the Ctenophylla are especially characteristic of the Rhætic and Lias.

Ctenophyllum taxinum, (Lindl and Hutt. spec.)

Plate XXXIII, Figs. 2 to 4.

Leaves linear; midrib strong; leaflets obliquely and closely placed, separate to the base in the lower leaflets, and united at the very base in the upper ones, either straight and of the same width to the ends, and there obliquely and bluntly rounded off, or slightly falcate, and narrowed towards the summits, and then obliquely rounded off; 12 millimeters long and 2 millimeters wide. Nerves very fine, parallel to each other and single.

This well-marked little plant is the exact counterpart of the *Zamia taxina* of Lindley and Hutton, figured on plate 175 of the "Fossil Flora of Great Britain," and obtained from the Oölite of England. The English authors were inclined to consider it as a smaller form of their *Zamia pecten* from the same formation. It seems to me, however, that it is a very well-marked and distinct species, for, in all the specimens seen by me, it retains the characters given on Plate XXXIII in Figs. 2 to 4, and does not approach *Zamia pecten*, or, as Schimper makes it, *Ctenophyllum pecten*, in any manner. This little plant has a close resemblance to the *Pterophyllum imbricatum* (Ctenophyllum of Schimp.) of Ettingsh., from the lower Lias of Steirdorf, except that the Steirdorf plant seems to have the leaflets more closely placed. I am inclined to think that this results from the manner in which the plant from Steirdorf has been compressed. The upward compression has apparently closed up the leaflets so as to make them appear imbricated. This is made highly probable by the fact that the *Zamites gracilis* of Andrae, which is figured by him in his "Foss. Flor. Siebenb. u. d. Banates," plate xi, figs. 4, 5, does not show this imbrication. This latter is from the same formation at Steirdorf, and is clearly the same plant with that of Ettingshausen. Andrae's plant is strikingly like the Virginia fossil. It is probably the same with it and the English plant.

There is also a certain resemblance to Heer's *Pterophyllum Meriani*, a figure of which is given in his "Flor. Foss. Helvetiæ, die Pfl. der Trias," plate xxx, fig. 9. Heer's plant, however, is considerably more robust, and the leaflets are wider than those of the Virginia fossil.

Formation and locality.—Found at Midlothian, on the same sandstone with *Pterophyllum affine.* Exact horizon not known.

Ctenophyllum truncatum, spec. nov.

Plate XXXVIII, Figs. 3 to 5.

Leaf (?) Leaflets obliquely placed, remote, narrowing gradually from the upper portion, which is the widest, and slightly decurrent on the midrib, truncate at the extremity. Leaf substance apparently thick. Nerves not fully shown, immersed in the leaf substance, very slender, forking at the insertion in some cases, all parallel to each other.

This plant, which must have been a very large and handsome one, was unfortunately found only in a very fragmentary condition, only two specimens being obtained. The best one is that given in Fig. 4. The leaflets of only one side of the leaf are shown, and they are all broken and crushed back, as shown in Fig. 4. The mode of insertion of the bases of these, and the other specimen obtained, show that the normal position of the leaflets is that given in Fig. 5. This plant has the oblique insertion of the leaflets found in Ctenophyllum, but has the leaflets truncate, like the true Pterophylla. Another anomalous feature is the shape of the leaflets, which have their greatest width at their extremities, but maintain this width for nearly half the length of the leaflet, and then narrow gradually to the base. The leaflets of only one side are to be seen, and only a part of the width of the midrib. As the impressions occur on a rather coarse sandstone, and the nerves are very delicate and immersed in the thick leaf substance, they are not fully disclosed, but appear to be as given in the diagnosis. It is noteworthy that the plants found in this sandstone occur in no other rock at Clover Hill, and they are very rare there. They are, along with the fossil now in question, *Lonchopteris Virginiensis*, *Clathropteris platyphylla*, var., *expansa*, *Podozomites Emmonsi*, *Macrotæniopteris crassinervis*, &c.

Ctenophyllum truncatum resembles closely no other previously described plant, unless it be the *Pterozamites spatulatus* of Emmons, "Am. Geol.," fig. 88. It has an obvious likeness to this plant, but in Emmons's plant the leaflets are represented as rounded off in an elliptical manner at the ends. Our plant is, besides, much larger than that of Emmons, both in the leaflets and midrib. It may not be a true *Ctenophyllum*, but perhaps is the type of a new genus. I do not feel at liberty to found a new genus on such an imperfect fragment, but place it provisionally in the genus *Ctenophyllum*, the one nearest to it among existing genera.

Formation and locality.—Found only at Clover Hill in siliceous sandstone, between the lower and main coal seams.

Ctenophyllum Braunianum var. *a*, Goepp.

Plate XXXIV, Figs. 2–4; Plate XXXV, Fig. 1; Plate XXXVII, Figs. 1, 2; Plate XXXVIII, Figs. 1, 2.

Leaf 40 centimeters and more in length, elliptical in outline. Petiole 20 centimeters and more in length, 1 centimeter in width. It is bare of leaflets. Midrib 1 centimeter wide, and gradually tapering towards the summit, where it is rapidly narrowed, and terminated by a single leaflet; sometimes an abrupt narrowing occurs some distance below the summit; irregularly striate, and bordered on each side of the upper surface, by a raised margin formed by the insertions of the thickened bases of the leaflets, flat in the central portions, and apparently rather fleshy. Leaflets attaining an extreme length of 10 centimeters, average length, 6 to 8 centimeters; width in middle, $1\frac{1}{2}$ to $2\frac{1}{2}$ millimeters, slightly expanded at base, and towards the summit tapering slightly, and bluntly rounded off, alternate, or subopposite, variously attached according to position, those at the base of the leaf going off often nearly or quite at a right angle, those in the middle, under an angle of about 45° and slightly curved upwards, those towards the summit of the leaf, under a more and more acute angle, until the terminal leaflet stands in the prolongation of the axis of the midrib. The lower leaflets which stand at right angles, or at a large angle, are usually separate, and sometimes remote, and not decurrent, those of the middle part of the leaf are separate to the base, and slightly decurrent, those of the upper part are united at base and strongly decurrent, all are thickened and more rigid at base, forming a raised line on the margin on each side of the midrib. Nerves strong, and slightly thickened at base, single, parallel to one another and to the margin of the leaflets, central nerves of the leaflets going off at right angles to the midrib, or under the same angle as the leaflet, the lateral ones leaving under an acute angle; about six in number, of which one or two are stronger than the rest; generally the central one is stronger when the inequality exists.

This splendid plant stands third in the abundance of its individuals and the area over which it is diffused. It is often found with *Macrotæniopteris magnifolia* as its sole companion, or with that plant along with *Equisetum Rogersi.* A fine-grained gray shale, not far above the main coal, is especially noteworthy for the thousands of imprints of this plant, along with the *Macrotæniopteris*, which occur in it, with almost never any other fossil. The great numbers of imprints of this plant, and the good preservation of many of them, enable me to make a very satisfactory study of it. It will be seen that within certain limits it is quite polymorphous. Fragments have been seen which indicate that the entire leaf, with its petiole, in the case of the largest specimens, could not have been much under a meter in length. The petiole must, in the largest specimens, have been considerably over 20 centimeters in length. Fragments of it 10 to 15 centimeters long occur in the gray shale. The width of the petiole of the largest leaves was at least one centimeter. The petiole was bare of leaflets, as is represented in Plate XXXVII, Fig. 1 *a*, which is a fragment of natural size, of a specimen about 15 centimeters long, which occurred on the same piece of shale with the fine specimen given in Fig. 1. The lower leaflets of the leaf are usually irregular in every way. They are more apt to be remotely placed than those of the middle and upper part of the leaf, and also to be abnormally wide and thick at base, to be shorter than the normal length, and to stand nearly or quite at a right angle to the midrib. Plate XXXIV, Fig. 4, and Plate XXXVII, Fig. 2, represent such portions of the lower part of the leaf. Plate XXXIV, Fig. 4*a*, gives the nervation of enlarged leaflets of Fig. 4. Plate XXXIV, Fig. 2, gives another form of the basal portion of a leaf, where the leaflets are closely placed and falcate, but much shorter than usual. The leaflets of the middle portion of the leaf, such as those represented in the lower part of Plate XXXVII, Fig. 1, and in Plate XXXVIII, Fig. 2, which is a fragment of a smaller leaf, go off at an angle of about 45° and are usually slightly curved upward towards the summit of the leaf. They here, as well as toward the summit of the leaf, are widest at base, and diminish in width almost imperceptibly until the tip of the leaflet is reached; here the leaflet is rounded off bluntly with an elliptical outline. The tips almost never are to be seen, since they are destroyed in the compression of the plant in the shale. The bases of the leaflets are thickened and rigid for some distance above the insertions. The part of the midrib upon which the bases of the leaflets rest is thickened, as represented in Plate XXXIV, Fig. 4, and Plate XXXVII, Figs. 1, 2. It forms a marginal line on each side of the midrib on its upper surface. The upper surface within these lines is irregularly striate and flat, but we sometimes find the stem traversed by two or three furrows or grooves besides the markings above mentioned. The lower surface of the midrib is usually smooth, cylindrical, and prominent, as in Plate XXXVIII, Fig. 2. The midrib tapers gradually from the lowest portion generally to the summit, where near the base of the terminal leaflet it is suddenly narrowed. Sometimes, however, the sudden attenuation takes place some distance below the summit, and then the tapering is gradual, until at the summit the midrib is abruptly terminated. The uppermost leaflets become more and more oblique in their insertion, and are usually united more or less at their bases. In the middle portions of the leaf their bases usually touch without being united, while in the lower basal portions they are often quite far apart.

The nerves are usually six in number, but some of them are more conspicuous than others, and then the middle one is generally the strongest. They are, in all cases seen by me, simple, and are somewhat thickened at base. The central ones stand at right angles to the midrib, or in the case of the obliquely inserted leaflets of the middle and upper part of the leaf, they make the same angles with the midrib that the leaflet does. In all cases the lateral nerves go off obliquely, and make a more acute angle with the midrib than the central ones do. All the specimens found belong to the var. α of Goeppert, or that with longer leaflets, and these attain a greater length than do those of Goeppert's plant. There can be no doubt, however, that this is the same species with that described by Goeppert from the Rhætic formation of Theta, near Bayreuth, and figured on Plate xxxviii, Figs. 1–10. Our plant, however, is much more like the plant described by Andrae in "Foss. Flor. Siebenb.," with the name *Zamites Dunkerianus*, and depicted on Plate XI, Figs. 2, 3. Schimper unites this plant with *Ctenophyllum Braunianum*. This plant of Andrae's is precisely like the Virginia fossil, except that it is smaller than the largest Virginia specimens. Many of the Virginia specimens are no larger, however, than this of Andrae. Brongniart has given a figure of a plant sent to him from the Richmond Coal Field, which he named *Filicites vittarioides*. It is clearly the plant now being described. The only difficulty in the way of identification is the statement of Brongniart, that the leaflets have regularly two nerves. This, I think, is a mistake, made from the fact that one or two of the nerves are often stronger than the rest. Brongniart had only an imperfect specimen, and it is not to be supposed that he could make out from it the true condition of the nerves. Professor Rogers, in his paper before referred to, describes a plant from the Richmond Coal Field, as *Zamites obtusifolius*, and gives a figure of it. He calls attention to the resemblance that it bears to Brongniart's plant. *Zamites obtusifolius* is clearly our plant, but is of smaller size than the largest obtained by me. Emmons found a plant in the Mesozoic of North Carolina, which he considered as possibly Rogers's *Zamites obtusifolius*. He gives a figure of it in fig. 85 of his American Geology. This plant seems to be clearly the same with the form of Ctenophyllum figured by Schenk on plate xxxviii, fig. 1, of his "Foss. Flor. d. Grenzscht."

Emmons's plant seems to differ from that of Schenk only in the slightly greater width of the leaflets, and their greater closeness. In these points it comes nearer, perhaps, to the plant from the Oölite of England, described as *Pterophyllum Preslanum*, Bronn, "Lethæa Geognostica," plate xiv, fig. 10, which is identified by Bronn and Schimper with *Zamites pecten*, of Lind. and Hutton. Emmons's *Pterozamites gracilis*, fig. 86, and his *Dioonites linearis*, plate iv, fig. 11, also belong to *Ctenophyllum Braunianum*.

The portion of the plant given in Plate XXXIV, Fig. 4, from the base of the leaf, with leaflets at right angles to the stem, much resembles Hugh Miller's fig. 133, of what he calls a Zamia, in his "Testimony of the Rocks." Miller's plant comes from the Upper Oölite of Helmsdale, Scotland.

Formation and locality.—Found at nearly all the plant localities in the Richmond Coal Field, both from below and above the main coal seam. Especially abundant above the main seam at Carbon Hill, in gray shale.

Ctenophyllum grandifolium, spec. nov.

Plate XXXIX, Figs. 1–3; Plate XL; Plate XLI; Plate XLII, Fig. 1.

Leaf very large, over a meter in length and more than half a meter in width. Midrib very broad, flat, and fleshy in texture, smooth, with a very thick, firm epidermis, which conceals the bases and the insertions of the leaflets, and causes it to appear wider than it really is. Leaflets in the lower part of the leaf, inserted at a right angle, remote, and of unequal widths, in the middle and upper portions more uniform in width and more closely placed, those of the middle portion of the leaf going off at an angle of 45° or one somewhat greater, separate to the base, becoming more and more oblique in insertion towards the upper part of the leaf, and united at their bases towards the summit of the leaf. They are over 30 centimeters in length, and from 10 to 12 millimeters wide in their middle portions, strap-shaped, and of the same width to near their bases, where they are gradually narrowed until the base is reached; here they are slightly expanded at their insertions, so as to be pro- and decurrent on the stem. The nerves are very strong and distinct, standing out like threads; they fork at, or near, the base, the branches diverge very slowly and then run parallel to one another and the margin of the leaflets. As seen under a lens, and sometimes without it, the apparent simple nerves are composed of two nerve-strands, so closely placed as to form a nerve-bundle which appears to be single. The leaflets appear to have been thick and firm, and to have had a dense epidermis.

I have been somewhat at a loss where to place this magnificent plant in the existing genera of cycadaceous plants. It is a good deal like the plants that Schimper puts in the genus *Macropterygium*, which are found in the black Triassic slate of Raibl. Our plant is most like the *Pterophyllum giganteum*, Schenk, a plant which Schimper names *Macropterygium Schenkii.* But Schenk's plant has the bases of the leaflets proportionally much more narrowed than they are in ours, and the leaflets appear to be laminæ, split by a peculiar mode of fissuring out of a broad leaf; and, besides, the nerves are not nearly so strong as they are in the Virginia fossil. I am all the more inclined to consider the Virginia plant not to be a Macropterygium, since the other species, *M. Bronnii* (*Pterophyllum Bronnii* of Schenk) is a flabellate leaf, cut into segments, and not unlike Nœggerathia. I have in no case seen the terminations of any of the leaflets, although I have found them 30 centimeters long. On the whole the plant agrees well with the diagnosis of the genus *Ctenophyllum*, the only difference being, perhaps, the slight expansion of the bases of the leaflets upon the midrib. This feature, however, is to be seen in the figures of *Ctenophyllum Braunianum*, given by Schenk on plate xxxviii of his "Foss. Flor. d. Grenzscht." Should the terminations of the leaflets be acute, it might well be a *Dioonites*, as limited by Schimper. It resembles *Pterophyllum Footeanum*, Feist., from the Upper Gondwanas of Vemavaram, as described by Feistmantel in the "Foss. Flor. of the Upper Gondwanas," series II, plate vi, figs. 1–6, but is a much larger plant. It is of the same type of plants as those fine Cycads, *Pterophyllum Kingianum*, Feist., *P. Morrisianum*, Old., *P. Carterianum*, Old., *P. distans*, Morr., from the Rajmahal Group of India. It is, however, a larger and finer plant than any of these.

Dr. Newberry, in Macomb's Report, gives, plate vi, fig. 7, a fragment of a large plant which he calls *Pterophyllum robustum*, which is much like our plant, though smaller. As it seems to me, the ends of the leaflets in Newberry's plant are not preserved, but the leaflets are broken off. Professor Rogers, in his paper before mentioned, speaks of finding great numbers of strap-shaped leaflets in the dark shale not far above the main coal, which, he says, are among the most abundant of the fossils of this shale. These impressions he attributes to a large Cycad, but as he saw neither their insertions nor their terminations he could not be sure as to their exact nature. From his description, they were clearly detached leaflets of *Ctenophyllum grandifolium.*

I had often, during my earlier visits to Clover Hill, found long, strap-shaped impressions, marked by very distinct lines, or nerves, which were very puzzling to me from their great length, their equality in width throughout, and from their showing neither insertion nor termination. . Some of these impressions were 30 centimeters long, the ends being still wanting, and of equal width throughout, being smooth and shining. They were evidently made by some portion of a plant which possessed a thick and firm character. It was not until after long search that I succeeded in finding the insertions of some of these strap-shaped bodies, and then I was surprised at the great apparent width of the stem to which they were attached. This stem, though very broad, was smooth and shining, and had, apparently, but little more woody tissue than the leaflets themselves, for it left flat, strap-shaped impressions, not unlike the impressions of the leaflets, except that the strong, regular nerves were wanting, and were replaced by an irregular striation. During my last visit I succeeded in finding the fine impressions which I reproduce in the figures now given. These were found in a very fine-grained, dark shale, which preserves very perfectly the entire leaf substance of the plant, which may be peeled off like paper. From the study of this material, which shows the character of the plant very perfectly, I was enabled to make out the details given in the diagnosis. The stem evidently had little woody matter in proportion to its size, and must have obtained much of its strength from the dense, strong epidermis which covered it and extended over the bases of the leaflets. Stripping off this epidermis, it is seen that the stem proper is much narrower than it appears to be when covered with it. I have depicted in Plate XXXIX, Fig. 2, the condition of things when the epidermis is removed, as it is in the upper part of the figure. Even in the stem proper the woody tissue is small in amount, and seems to have been immersed in fleshy matter. The epidermis over the leaflets, though thick and strong, is not so much so as over the midrib. The length of the leaflets seems to have rendered them very liable to be torn off and scattered, for we find great numbers of scattered leaflets, but very few stems with leaflets attached. From the numbers of these leaflets near the top of the main coal we may conclude that they, with their fleshy stems, contributed a good deal of material for the formation of the coal. It is much to be regretted that the strata overlying the main coal are never opened in the ordinary working of the coal, for they seem to be rich in a very interesting series of plants.

Plate XXXIX, Fig. 1, of natural size, will give some idea of the great apparent width of the flat stem, for its entire width is not preserved, yet it is over 2 centimeters wide. It represents the stem with the epidermis in place. Plate XL gives the lower portion of a stem, but without showing any portion of the petiole. It will be seen that here the leaflets are remote, unequal in width, and at right angles with the stem. Plate XLI, Fig. 1, represents the middle portion of the same leaf, and Plate XLII, Fig. 1, the upper part of it without showing the summit. These three specimens all probably formed portions of the same individual plant. If we join them together, supply a petiole of proper dimensions, and imagine the leaflets prolonged to the length of about 40 centimeters, we have the true dimensions of this magnificent plant. Plate XXXIX, Fig. 3, gives a fragment of a smaller specimen. Fig. 3 *a* is a slightly enlarged leaflet of it, to show the nervation. Plate XLII, Fig. 1 *a*, is a portion of a leaflet with the nervation enlarged very slightly, just enough to show the distinctness of the two strands composing each bundle. Without the help of a lens they are not usually seen so distinctly to be separate. Fig. 1 *b* represents an enlarged portion of the base of a leaflet, giving the insertion of a single nerve-bundle, to show the slow divergence of the branches after forking, which is very common in the nervation of this plant. This represents what would appear, without the help of a lens, to be a strong single nerve, which forks some distance from its insertion.

Formation and locality.—Found in great abundance at Clover Hill, in fine-grained dark shale which comes over the main coal, and forms its roof.

Ctenophyllum giganteum, spec. nov.

Plate XXXIX, Fig. 5.

Leaf? Leaflets very large, 28 millimeters wide, nerves very strong and prominent, forking near the base, and then single and parallel to one another and to the margin of the leaflet.

Only a fragment of a leaflet of this plant was seen, so that its true character cannot be made out. It was evidently a fragment of a very large plant of the same character as *Ctenophyllum grandifolium*, and may possibly be a portion of a very large specimen of this species. The leaf substance was so thick, and the nerves so strongly defined and so remote, that at first I supposed it to be the impression of the interior of the stem of an Equisetum. The nerves, however, forking near the base, and a small part of the stem, to which the leaflet was attached, make it plain that it is a portion of some Cycad of very large size.

This fragment seems to me to be a good deal like the large leaflet of what Schenk calls *Zamites distans*, Presl., which he figures on plate xxvi, fig. 10, "Foss. Flor. d. Grenzschicht." The large size of this leaflet, and its strong and remote nerves, are points very similar to those of our plant. The only difference is the fact that Schenk's plant narrows towards the base.

Formation and locality.—Found only at Clover Hill, and there very rarely in detached leaflets, in the sandstone with Clathropteris.

PODOZAMITES, Fr. Braun, emend.

Leaves of moderate size, midrib slender, leaflets distant, spreading, oblong-ovate, and linear-oblong, obtusely acuminate, or rounded at the ends, and towards the base sensibly narrowed, deciduous, supported on a short pedicel, pedicel articulated and decurrent. Nerves dichotomous from the lowest part of the base of the leaflets, and from that point simple, parallel, and converging towards the tips of the leaflets.

The plants with this character are not very common in the Richmond Coal Field, either in species or individuals. This scarcity, however, may be more apparent than real, as the leaflets are so deciduous that they are rarely found attached to the stems. The scattered leaflets are not uncommon.

Podozamites Emmonsi.

Plate XXXIII, Fig. 2.

Podozamites lanceolatus, Emmons. Am. Geol., Plate III, Fig. 7.

Midrib strong, striate, leaves subopposite or alternate, elongate, elliptical, or lanceolate in shape, abruptly narrowed at base into a very short pedicel, which is twisted and decurrent on the midrib, nerves strong, and otherwise with the generic character.

This fine plant seems to have been named by Emmons because he identified it with the *Zamites lanceolatus*, of Lindley and Hutton. It is really quite different from this plant, and indeed from all previously described plants of the genus Podozamites. It is then a new species, and I have given it the name of its discoverer, as the name *Podozamites lanceolatus* is preoccupied, Schimper having changed the *Zamites lanceolatus* of Lindley and Hutton to *Podozamites lanceolatus.* This species and the one next to be described suggest very strongly an affinity with some conifers. Emmons says that the detached leaves are numerous in the slates at Ellingtons, in North Carolina, some of them being 12 millimeters wide. I have found only a single small specimen in the Virginia Mesozoic, and it is certainly quite rare there.

Formation and locality.—Found only at Clover Hill, with Clathropteris, *Ctenophyllum truncatum*, &c., in sandstone between the lower and main coal seams.

Podozamites tenuistriatus.

Plate XLII, Figs. 2-5.

Zamites tenuistriatus, Rogers.

Leaf ?. Midrib rough, and irregularly striate. Leaflets going off at an angle of 45°, or at a right angle, inserted by a twisted, very short pedicel, which is slightly decurrent, very deciduous, abruptly narrowed at base, and rounded off more sharply on the lower side, but more gradually on the upper side, widest near the base, and tapering thence to the summit, quite closely placed, subopposite or alternate, nerves very delicate, forking at or near the base, and sometimes forking again a short distance above the base, then parallel to near the extremity, where they converge and meet.

The nerves of this plant are usually so fine that they cannot be seen distinctly, except near the base where they are rather stronger. They seem to differ from those of most species of Podozamites, in branching more than once in some cases. The leaflets, too, differ from those of most previously described species of the genus, in their closeness, small size, and the large angle under which they leave the midrib. It is something like *Podozamites angustifolius*, Schenk, of the Rhætic near Bayreuth, but the leaflets of Schenk's plant seem to be more remote, and to go off under a much smaller angle. Professor Rogers mentions in his account of the plants of the coal of Eastern Virginia, a fossil which he calls *Zamites tenuistriatus,* which must be the plant now in question. He seems to have obtained only obscure specimens, but distinct enough to make out the shape of the leaflets, and the general character of the nervation, which features are evidently, from his account of them, those of this plant. The leaflets of this plant are very deciduous, and it is a very rare thing that they are found attached to a stem. They usually appear scattered over the surface of the shale, and the stems, quite bare of leaflets, or containing only one or two, are to be seen mingled with the dispersed leaflets. Fig. 3 represents quite a common form in which the leaflets have the smallest size found in the species. In Fig. 3 the rough irregularly striate midrib is shown, and the slight prominences which mark the bases of the pedicels. Fig. 3 *a* gives an enlarged leaflet with nervation, and Fig. 3 *b*, the summit of the same still more enlarged. Fig. 2 represents a larger form of the leaflets. Here they vary in shape from those seen in Fig. 3. They are larger and more uniform in width. Fig. 5 gives a leaflet of this form of the largest size. Fig. 4 gives a form obtained from the Cumberland Area near Farmville, in which the leaflets appear to have their pedicels placed more on the upper face of the midrib than in the normal forms, where they are attached on the sides. This mode of attachment may result from the mode of preservation of the specimen. This small species is evidently of the same type with *Podozamites Emmonsi*, and the two differ quite considerably from all previously described forms of Podozamites.

Formation and locality.—This plant is the most abundant form of Podozamites found in the Virginia Mesozoic and is widely diffused. It is one of the few plants found in the Cumberland area, and it occurs at all the localities yielding plants in the Richmond Coal Field. It is not uncommon in the form of scattered leaflets at Carbon Hill, Midlothian, Clover Hill, and Deep Run, occurring in the shales between the lower and the main coal seams. These shales and sandstones overlying the lower coal appear to be richer in plant impressions, and to have a greater number of species than any other series of strata.

SPHENOZAMITES, Brongt.

Leaf pinnate, with usually a strong smooth stem; leaflets, the broader ones, large, more or less narrowed at the base, equilateral, begirt with a narrow cartilaginous margin, entire or sinuate at the apex, and spinously dentate, inserted on, or near, the sides of the midrib, always separate to the base, subpediceled, never covering the upper surface of the midrib; nerves radiating from the place of insertion, numerous, and several times branching dichotomously.

This is Saporta's diagnosis of the genus, and I follow it with only the change of the words "on the sides," to "on, or near the sides of the midrib." He says of these plants, very justly, that they are rare everywhere, and, as yet, imperfectly known; that the leaflets were articulated to the common stem, and hence they appear more commonly isolated, and not attached, and, further, that they mark the age of the highest development of the Cycadaceous plants, and are themselves the most finished type of these plants. All these statements would seem to apply to the splendid plant presently to be described, and which is the only one of the genus as yet found in Virginia. The oldest Sphenozamites, according to Saporta, appear in the lower Oölite, they are abundant in the middle Oölite of the Venetian Alps, and range as high as the upper Oölite. They are, then, plants especially charactistic of the Oölite, and the discovery of so fine a specimen of the genus in the Richmond Coal Field is of great importance. As there are many species of the Rhætic, either identical with those of the lower Oölite or closely allied to them, it need not surprise us to find a Sphenozamites among Rhætic plants. The species now in question is, then, the oldest Sphenozamites, as yet, found.

Sphenozamites Rogersianus, spec. nov.

Plate XLIII, Fig. 1; Plate XLIV, Figs. 1, 2; Plate XLV Figs. 1, 2.

Leaf very large, in the largest forms 1 meter at least in length; width, 40 to 50 centimeters. Midrib very strong, rigid, and woody, 1 to 1½ centimeters wide, rounded in form on the lower surface, and flattened on the upper surface, strongly and irregularly striate and ridged. Leaflets rather remotely inserted, opposite or subopposite; in the middle and lower parts of the leaf, standing at right angles to the midrib, in the upper portions, becoming more and more oblique in insertion, until the terminal leaflet stands on the summit of the midrib, forming the prolongation of its direction. The leaflets are very large and narrowed towards the base so as to have an elliptical outline, and at the lowest part of the base are abruptly rounded off, and narrowed into a very short pedicel which is obliquely inserted somewhat within the margin of the midrib. They widen in a flabellate manner towards their ends so that in the middle and upper parts they overlap one another. They are widest at and near the extremities, which are cut away obliquely from the upper part of the termination to the lower part and rounded off so that the lower margin of the leaf is longer than the upper one. All are bordered by a very narrow cartilaginous rim which is formed by the thickening of the edge of the leaflets. While the lateral leaflets are wedge-shaped with obliquely sloping terminations the terminal leaflet is exactly and symmetrically wedge-shaped. The nerve-bundles, by their close approximation at the base of the leaflets, form the pedicels by which they are attached, and which are slightly decurrent on the midrib. The nerves start from the pedicel as strong bundles, composed of two nerve-bundles. On passing into the limb of the leaflet the double bundles slowly diverge dichotomously, each branch of the fork being composed of a nerve-bundle formed by two closely approximated nerves which, unless seen under a good lens, appear as single nerves. The two nerves composing each branch then slowly diverge dichotomously. Each is at first single, but in its further course becomes in turn a bundle of two closely approximated nerves, which slowly diverge and produce a forking again in a similar manner. The dichotomous branching occurs quite often in the lower third of the leaflets, but in the upper portions the forking is very rare, and the nerve-bundles run for long distances parallel to each other. Between the nerves there is a fine granulation which, seen under a lens, is composed of globular prominences or dots which do not seem to be anything but a fine granulation of the epidermis. Sometimes, owing to distortion from pressure, these dot-like elevations are drawn out into little bars which extend from nerve to nerve and look like transverse nerves.

The remarkable nervation of this plant thus described is that seen with the help of a good lens on well-preserved specimens. To the unassisted eye the nerves seem to issue from the pedicels as single strong nerves, which then repeatedly branch in a dichotomous manner and fill the leaflet. The nervation is seen to be freely branched in the lower part of the leaf, while in the upper part the branches run for long distances parallel to each other. The granulation also is very distinct without the help of a lens, and appears either as dot like prominences or transverse bars from branch to branch. With the help of a lens we find that the apparently sharply-defined single nerves are really composed of two nerve-strands, so closely placed that they appear as one nerve. It is seen also that what appear at the base of the leaflets to be single strong nerves are really nerve-bundles made up of two double nerves, so close together as to give the appearance each of a single strong nerve. In other words, here the four nerve-strands are crowded together in the same way as the two nerve-strands are higher up in the leaflet. Following with the eye one of these strong bundles at the base of the leaflet as it passes higher into the leaflet, we find that the two pairs of nerves slowly diverge, giving what appears to the unaided eye to be a dichotomous forking of a single nerve. Each pair, some distance higher up, forks dichotomously by the very gradual separation of the two nerve-strands which compose it. These two nerve-strands are at first single, so far as can be made out with the lens, but they soon become double, and now in their turn fork, as before described. Nothing definite can be seen in the granulation that covers the leaflets. This granulation does not appear to be anything like fructification.

In my first collections of plants from Clover Hill I had found fragments of leaves having the above-described character, but usually showing only small bits of the leaflets, and sometimes ends of the same nearly entire. The preservation of the ends of the leaflets in these cases is due to the fact that the cartilaginous border that runs around the edge of the leaflets is thicker at the ends than elsewhere. The leaflets often show a tendency to split longitudinally. It was not until my last visit to the above-named locality that I succeeded in finding quite complete specimens. On this occasion I was fortunate in finding several fragments showing a number of attached leaflets, with the terminal leaflet, as well as several large specimens containing attached and very large lateral leaflets, from portions lower down on the leaf. Some of these were well enough preserved to show all the details of the nervation. In all the cases where I have indicated the outline of the entire leaflets by dotted lines on fragments I have done so after seeing such restored parts on other and detached leaflets. Thus while for the individual fragmentary specimens the dotted outline is ideal, it represents dimensions and shapes actually seen on other specimens. Plate XLIII, Fig. 1, represents a specimen of one of the smallest forms of the plant of natural size, and as seen in one specimen. It will be seen in this specimen that while the basal portions of the leaflets and their insertions are quite well preserved, yet the upper parts of the leaflets do not show their true width, owing to the laceration of their margins, while the ends of all are missing. The nervation and granulation are given on the terminal leaflet and one of the lateral ones, as they appear to the unassisted eye. The great strength of the midrib of the plant is plainly shown in this specimen. Here, not far from the termination of the leaf (for the specimen is the upper part of a leaf) we find the midrib to be nearly $1\frac{1}{2}$ centimeters wide. The entire leaf could not be less than a meter in length. Plate XLV, Fig. 1, gives a more fragmentary specimen, in which the terminal part of a leaf is seen, and in which I have restored by the dotted lines the outlines of the leaflets as they must have existed. The shape of the terminal leaflet is given as seen in a specimen where its true outline could be made out. This specimen seems to have belonged to a larger leaf than that depicted in Plate XLIII, Fig. 1. Plate XLV, Fig. 2, gives the dimensions of one of the largest leaflets. In it the lower part of the leaf only is seen, but the length is restored from actually seen and measured lengths on leaves of this size. Plate XLIV, Fig. 2, gives the nervation and granulation somewhat enlarged, and Fig. 2 *b* represents a portion of the leaf where the dots are elongated by pressure into transverse bars. This portion is still more enlarged. Plate XLIV, Fig. 1, gives the bases and portions of four large leaves and the stem on which they are inserted. One of the leaves is nearly entire. Plate XLIV, Fig. 2 *a*, gives the mode of consolidation and divergence of one of the nerve-bundles which leave the pedicel to enter the leaflet. It is enlarged to show the appearance as seen under a strong lens.

It will be seen that this fine plant in some features differs from previously-described species of Sphenozamites. The pedicels are inserted somewhat within the margins of the stem, and this has led me to modify the diagnosis of Saporta so that it may read: "Leaflets inserted on or near the margin of the stem." This is justified by what is seen on the plants of this genus which have been previously described and figured. It is clear that the leaflets of *S. latifolius* Sap. were not inserted exactly on the side of the stem, but a little within its upper surface. This is also the case with *S. Rossii*, Zign., a figure of which is given by Saporta in the "Pal. Française Plantes jurass.," plate cxiv, fig. 2, where the bases of some of the leaflets are attached a little within the margin of the upper surface of the stem. The peculiar nervation of *S. Rogersianus* is not given in any previously described species, but this may arise from the fact that the nervation was not so well shown as in the Richmond plant.

Dr. Emmons gives a representation of a leaf marked with delicate transverse bars on the veins in plate 6, fig. 5, of his "American Geology," which is, I suppose, the plant he describes on page 35 as *Calamites punctatus*, although he refers for the figure of this to plate 2, fig. 5. This is clearly the same with the plant now in question, as may be easily seen from the figure. He takes it to be a stem, but sees no articulations on it.

Dr. Newberry gives a figure on plate viii, fig. 5, of a plant found at Sonora, in his report on the Macomb Expedition. It is the summit of a flat, broad leaf, with longitudinal nerves, and covered with fine punctate dots. It seems to be a fragment of a leaflet of a species like our plant. Its affinity with the Virginia plant is made more probable by the resemblance which many of the plants found in Sonora bear to some of the plants of the Richmond Coal Field.

Formation and locality.—Not uncommon at Clover Hill in strata associated with the main coal seam and found only here. I have named the plant in honor of Prof. William B. Rogers, who was the first to call attention to the plants of the Mesozoic of Virginia.

CYCADEÆ.

CYCADITES, Brongt.

Cycadites tenuinervis, spec. nov.

Plate XLIV, Figs. 4 to 6.

Leaves elliptical-lanceolate or linear-lanceolate. Midrib strong and irregularly striate. Leaflets falcate, acute, closely placed, subopposite or opposite, rather thick and fleshy. Middle nerve very slender and immersed in the parenchyma of the leaflets.

This plant has been found as yet only in the northern extension of the Richmond Area, in Hanover County, where it occurs with great numbers of *Macrotæniopteris magnifolia* in a yellowish gray shale which preserves the specimens very poorly. The horizon seems to be about that of the coal-bearing portion of the Richmond Coal Field, and a thin, impure seam of coal is found near the locality of the plants. The nerve of the leaflets is not well disclosed, owing to the thickness of the leaf substance, the poor preservation, and its immersion. Often it can be made out only at the base of the leaflets, as in Figs. 4 and 6. The leaves have been found only in fragments, and appear to have been elliptical-lanceolate or linear-lanceolate in form. This plant is most strikingly like *Cycadites Cutchensis*, Feist., from Kukurbit, India, in strata which Feistmantel considers to be of Oölitic age. He gives a representation of his plant in plate xi, figs. 5, 5 *a*, in "Palæontologia Indica," series xi, 1. All the details of the two plants are similar, except that the plant from India has its leaflets not so closely placed and rather more obliquely inserted.

Formation and locality.—Found only in Hanover County, in strata belonging to the horizon of the coal of the Richmond Coal Field.

FRUITS OF CYCADS.

ZAMIOSTROBUS.

Zamiostrobus Virginiensis, spec. nov.

Plate XLVII, Figs. 4, 5.

Cone oblong, elliptical in outline. Scars of the carpellary scales near the borders smaller or indistinct, those towards the central parts having a raised quadrilateral form, the two lower sides of the quadrilateral being longer, the two upper shorter, and making a more obtuse angle with each other than the two lower do. The quadrilateral spaces have in their center an elongated, rhomboidal space which in one form is prolonged into a line in all the angles except the upper, and in another form has the prolongations in the lateral and lower angles while the two upper sides no longer meet at an angle as in the first-named form, but join so as to form an arc of a circle.

Several fragments were found which were plainly impressions of the fructified cone of a zamia-like plant. The scars left by the scales of the cone vary somewhat. Those of the form given in Fig. 4 have the shape of the magnified imprint given in Fig. 4 *a*, where the rhomboidal space perched on the summit of the quadrilateral area is symmetrical and has all the angles except the upper one drawn out into lines. The other form of scar is found in Fig. 5, and is represented magnified in Fig. 5 *a*. Here the upper angle of the rhomboidal central area is opened out into the arc of a circle. These impressions were found with *Podozamites tenuistriatus*, and as this was the only Cycadeous plant found at this locality which could furnish the leaves for the fructification in question, it is probable that both the cone and leaves belong to the same plant.

Formation and locality.—Found only at the Gowry Shaft, near Midlothian. Horizon unknown.

CONIFERÆ.

BAIERA, Fr. Braun.

Leaves coriaceous or more or less cartilaginous, narrowed from the base into a rather thick, short, or long petiole, and divided above the basal portion into linear segments, which are themselves split dichotomously into smaller segments which are also linear. Nerves numerous, at long intervals dichotomously divided, and for the most part parallel to one another and to the margins of the laciniæ.

This genus has been placed by Heer and Saporta in the group of the Salisburiæ among the Coniferæ. The genus is represented in the Virginia

Mesozoic by the single species presently to be described. Saporta says that Baiera seems to have preceded Salisburia, and that the *Gingkophyllum grasseti*, Sap., from the Permian of Lodove, has at the same time some of the characters of the true Salisburia and of Baiera. It is interesting to note that the Upper Carboniferous beds of Southwest Pennsylvania and West Virginia contain a plant, *Baiera Virginiana*, F. and W., which, if it is not a Gingkophyllum, is a true Baiera. The absence of the base of the leaf leaves this point in doubt. This fossil occurs in the same beds with a plant closely allied to Salisburia, viz., *Saportea*, F. and W. The Saportea does not appear in the Virginia Mesozoic, or at least it has not yet been found. It would seem that the type of Baiera and Salisburia appeared together in the closing era of the Paleozoic. In this connection I may be permitted to call attention to the remarkable apparent scarcity of coniferous plants in the Virginia older Mesozoic. It is not to be supposed that they were not present in that era. I think that the great predominance of Ferns, Cycads, and Equisetum, the latter in individuals at least, in the fossils found in the Virginia Mesozoic, is due to the fact that these plants grew near the shores of the lakes and on islands in them, and thus their remains were more readily preserved in the sediment accumulating in the still shallow waters. Such quietly accumulated sediment was the only material that could preserve the foliage of plants. That coniferous plants were not wanting in the Mesozoic is shown by the fact that wherever the strata are of such a character as to indicate the presence of bodies of water in motion, such as rivers or floods from the highlands, then we do find abundant traces of coniferous vegetation. Thus in the sandstones of the lower series we find coniferous wood usually silicified, but it is especially in the upper series or that characterized by the large amount of granitic sand that we find the greatest amount of coniferous relics. Here the materials are sometimes silicified, but generally they occur in the form of lignite and jet. In many places we may find layers of some extent, and sometimes a foot thick, of lignite formed by the drifting of trees and their branches and the piling up of the same. Often isolated trees which must have been a foot or more in diameter occur imbedded in the sandstones and shales of the upper measures, but which are now flattened by pressure. The wood seems to have had a fine uniform grain and to have resembled the wood of *Pinus Strobus.* The absence of foliage, of fruits, and of branches or recognizable markings, seems to indicate that this wood has traveled a long distance in the currents which transported the coarse sediment. All the facts then indicate that while the low grounds and marshes abounded in Ferns and Equiseta, the high and remote grounds were covered with coniferous plants.

Baiera multifida, spec. nov.

Plate XLV, Fig. 3; Plate XLVI, Figs. 1–3; Plate XLVII, Figs. 1, 2.

Leaves narrowed below into a peduncle and divided dichotomously into numerous laciniæ, which are strap-shaped, and in the ultimate divisions narrow and linear; leaf substance coriaceous, but not very thick, nerves strong, closely placed, forking dichotomously at long intervals, parallel to one another and to the margins of the laciniæ.

There is some variation in the mode of division of the leaves of this plant. Quite a common form is that shown in Plate XLVI, Fig. 1, where the leaves start with a cuneate base and divide first into two segments, which in turn, by repeated division in a dichotomous manner, finally form narrow thong-like laciniæ, which are about 3 millimeters wide. These may subdivide again, but I have never seen the laciniæ any narrower. The tips of these divisions are wanting in the most complete specimens seen, so that the leaf must have had a length greater than that of the largest specimen found, or that depicted in Plate XLVI, Fig. 1. This leaf must have had a length of over 25 centimeters, not including the petiole. Plate XLVII, Fig. 2, represents segments of a leaf which must have been even larger. The plant depicted in Plate XLVII, Fig. 1, must have had a great expanse laterally, as well as in length. In Plate XLV, Fig. 3, the mode of division near the base of the leaf is different from that seen in the above-named figures. Here the formation of numerous segments of nearly equal width would give the leaf more of a flabellate shape. The plant is quite abundant at Clover Hill, and is not uncommon at Carbon Hill. Strange to say I have not succeeded, in a single case, in finding the petiole, although I sought for it persistently, and we would expect to find this portion more commonly than any other, as its greater thickness and strength would cause it to have a better prospect of preservation than the thinner and more fragile blade of the leaf. Can it be because these petioles were persistent, and the long laciniæ of the leaves caused them to be frequently torn off without carrying the petioles with them?

This plant can be identified positively with no previously-described species known to me. It is far larger than any previously known. Dr. Emmons gives a figure in his "American Geology" of a poorly preserved fragment of a plant which he calls *Nœggerathia striata*, fig. 96. This fragment is, I think, the basal portion of one of the leaves of *Baiera multifida*. This plant occurs, as Dr. Emmons says, on the same horizon with the beds furnishing so many cycads and calamites.

Formation and locality.—Abundant at Clover Hill in the strata between the bottom and main seams of coal, and not uncommon at Carbon Hill on the same horizon.

CHEIROLEPIS, Schimper.

Branches unequal and distichous. Leaves densely crowded, spirally tetrastichous, small, decurrent at base, lanceolate-acute, subfalcate-incurved, with a strong midrib, thick and dense in texture.

This plant has been called by various names, such as Brachyphyllum and Pachyphyllum. Under the name of Brachyphyllum, Schenk describes two forms occurring in the Rhætic of Franconia, which I consider identical with the plant found in the Virginia Mesozoic. Schimper unites the *B. affine* and *B. Münsteri* of Schenk, and gives the plants the name *Cheirolepis Münsteri.*

Cheirolepis Munsteri (Schenk), Schimper.

Plate XLVII, Figs. 6, 7.

Branches distichous, leaves thick in texture, decurrent at base, with a strong middle nerve, lateral leaves somewhat spreading, and falcate-incurved, acutely acuminate, ovate or oblong in shape, those on the front and rear surface smaller and closely appressed.

There is an apparent difference between the front and rear leaves and those laterally placed, which may result in large part from the compression of the branches. The lateral leaves appear spreading and incurved, while those on the front aspect are apparently smaller and fewer, and are pressed so closely to the stems that they are often with difficulty made out. The midrib is large and sometimes leaves an impression on the shale of the depressed line on each side of it, which being seen in relief, looks as if the leaf had two nerves. I have found only two very small fragments representing the terminal portion of two small branches. They were found in the Cumberland area. Professor Rogers states that he found different parts of the plant, and among them, the cone, but does not give the locality and horizon. I give in Plate XLVII, Fig. 6, a copy of his figure of the plant as presented in the article on the "Age of the Coal Rocks of Eastern Virginia," before referred to. He says of the plant that it strongly resembles *Lycopodites Williamsoni*, Brongt., which is Phillips's *Lycopodites uncifolius*, from the Yorkshire Oölite He says, "The one, sometimes two, strongly marked ridges up the center of each leaf, the oppositely placed leaves with the smaller ones between, the scales upon the stems, the cones with the strongly marked rhomboidal, spaces like scars, and the peculiar claw-like form of the leaf, especially when full grown, are all distinctly exhibited in the Virginia fossil."

The parts of the plant that I have seen, and the figure of Professor Rogers, while indicating a plant something like the Yorkshire one, belong to really quite a different fossil, and one which is much more slender, and does not have the thick tetragonal leaves of the Yorkshire plant, which is a Pachyphyllum. The leaves of the Virginia fossil, though thick, are by no means so much so as the *Pachyphyllum* (*Lycopodites*) *Williamsoni.* They are flat, and marked by a well-defined midrib. Dr. Emmons gives ("Am. Geol.," fig. 75), a representation of a fossil which is clearly allied to the Virginia plant. Emmons calls this plant *Walchia gracile.* The plant he gives in fig. 76, as *Walchia variabilis* is probably a Pachyphyllum. He says nothing about the presence of a midrib, but one seems to be indicated in the figure. Emmons's fig. 74, of *Walchia brevifolia* is no doubt a Cheirolepis. Dr. Newberry, in Macomb's Report, plate iv, fig. 4, plate v, fig. 4, and plate vi, fig. 9, gives representations of twigs of conifers which appear to belong to this species.

Formation and locality.—Found by me only in the Cumberland Area, on the horizon of the coal beds of that area.

UNDETERMINED PLANTS.

In Fig. 2, Plate XLVIII, I give a representation of a plant which was found in the Cumberland Area with only the small fragment given in the figure. It occurs in the black shale on the horizon of the coal beds of this area, along with *Equisetum Rogersi*, *Pterophyllum decussatum*, and the fragments presently to be described. It is marked by rather strong, closely placed nerves, which fork at long intervals. The mode of forking of the nerves resembles that of *Sphenozamites Rogersianus*, but the dots and bars always seen on this plant do not occur here. The specimen seems to be a fragment of a large leaf. It may be a portion of a large fern.

Bambusium?

Plate XLVIII, Fig. 3.

Fig. 3, Plate XLVIII, gives a representation of a grass-like fragmentary leaf, marked with closely placed, rather strong, and very distinctly defined nerves. Between each of these, with the help of a lens, may be seen one and sometimes two very fine lines. Fig. 3*a*, represents a portion of the leaf magnified to show this line in the interspace between the nerves. Fig. 3, does not seem to represent the original width of the leaf, for the specimen has evidently had a portion torn off from its side. It is found with the above plant. It may be a Bambusium.

In Fig. 4, Plate XLVIII, I give a representation of a singular group of fragmentary leaves. Several specimens have been found, with the above mentioned plants, in the black shale of the Cumberland Area. None of the specimens show very distinctly the character of the plant. The appearance presented is that of a bunch of very thin, rather narrow leaflets, that have been crowded by compression over one another, so that only the lacerated ends and edges are to be seen overlying one another. Several of these occur in the specimen figured. The strong irregular lines of the figure are the free lacerated edges of the superposed leaves. They suggest the idea that they spring divergently from a common point. The nerves of the leaves appear as fine striæ, too fine to be seen distinctly without the help of a lens. I have represented these fine striæ on portions of the leaves. The grouping of the leaves reminds one of Heer's genus Phœnicopsis.

Undetermined Cones.

Plate XLVII, Fig. 3; Plate XLVIII, Fig. 1.

I have here given two figures of what appear to be cones of some conifer which had elongate spindle-shaped cones. A group of three of these was found on a small fragment of argillaceous flaggy sandstone at Clover Hill. They were all fragmentary and very poorly preserved. I have figured the two most distinct specimens. Fir cones six inches long are reported from the Mesozoic strata at Phœnixville, Pa. I have never seen them. They may be the same with the cones now in question, or nearly allied to them.

Undetermined Stem.

Plate XLVIII, Fig. 5.

I have given in Plate XLVIII, Fig. 5, a representation of the markings made by a portion of the exterior of some stem. It appears to be the stem of a cycad, somewhat like that drawn by Williamson in his article on the history of *Zamia gigas*, Trans. Linn. Soc., vol. xxvi, plate 53, fig. 5. This fossil is held by Williamson to be the stem of *Zamia gigas*, Lindl. and Hutt., from the Oölite of England. Williamson gives in fig. 5, plate 53, the scars left by the bases of the leaves on this stem. They are raised and rhomboid to elliptical in shape, and have the greater length in the direction of the axis of the stem, being surrounded by a deep depression. The scars are arranged in quincunx. The impressions of the scars left by the plant now in question are a good deal like these in their general shape, and in having their larger axis apparently turned in the direction of the length of the stem and not transverse to it, as in the stem of most cycads. These scars are depressed, and have the marks of a vascular bundle at their upper end. They have a resemblance to Lepidodendron scars. The stem may possibly have been that of a conifer. Fig. 5*a* gives one of the scars magnified. The border of the scar is raised, forming a ridge.

GENERAL OBSERVATIONS ON THE FLORA.

An account having now been given of all the plants as yet found fossil in the older Mesozoic strata of Virginia, the general relations of this flora may now be considered.

The following table gives the plants arranged under several heads: 1. Those plants peculiar to the older Mesozoic of Virginia, and without near relations in other countries. 2. Plants found in the Trias of other regions, or nearly related to Triassic plants. 3. Plants found in the Jurassic of other countries, or nearly related to such plants. 4. Rhætic plants, or those nearly allied to such.

Fossil Plants from the Older Mesozoic of Virginia.

Fossil plants from the older Mesozoic of Virginia.	Plants peculiar to Virginia.	Plants found in the Trias or allied to such.	Plants found in the Jurassic or allied to such.	Plants found in the Rhætic or allied to such.
Equisetum Rogersi			Allied to *E. columnare.*	
Schizoneura, species ?	×			
S. Virginiensis		Near to *S. Meriani.*		Near to *S. hoerensis.*
Macrotæniopteris magnifolia				Very near to *M. gigantea.*
M. crassinervis			×	
Acrostichides linnææfolius				Near to *A. Goeppertianus.*
A. rhombifolius		Allied to *Neuropteris Schœnleiniana.*		Allied to *Cyclopteris pachyrachis.*
A. microphyllus	×			
A. densifolius	×			
Mertensides bullatus	×			
M. distans		Near to *Pecopteris gracilis.*		Near to *Gleichenites microphyllus.*
Asterocarpus Virginiensis	×			
A. platyrachis		Near to *A. Meriani.*		
A. penticarpus	×			
Pecopteris rarinervis	×			
Cladophlebis subfalcata				Allied to *Asplenites Rösserti.*
C. auriculata	×			
C. ovata	×			
C. microphylla	×			
C. pseudowhitbiensis	×			
C. rotundiloba	×			
Lonchopteris Virginiensis	×			
Clathropteris platyphylla, expansa.			×	
Pseudodanæopsis reticulata	×			
P. nervosa	×			
Sagenopteris rhoifolia				×
Dicranopteris spec. ?				Near *D. Römeriana.*
Pterophyllum inæquale			Near *P. Andræanum.*	
P. affine				×

Fossil Plants from the Older Mesozoic of Virginia—Continued.

Fossil plants from the older Mesozoic of Virginia.	Plants peculiar to Virginia.	Plants found in the Trias or allied to such.	Plants found in the Jurassic or allied to such.	Plants found in the Rhætic or allied to such.
P. decussatum			Near to *P. Andræanum*	
Ctenophyllum taxinum			×	
C. truncatum	×			
C. Braunianum				
C. grandifolium	×			
C. giganteum	×			
Podozamites Emmonsi			Near to *P. lanceolatus*, minor.	
P. tenuistriatus	×			
Sphenozamites Rogersianus	×			
Cycadites tenuinervis			Near to *C. Cutchensis.*	
Zamiostrobus Virginiensis	×			
Baiera multifida				Allied to *B. tæniata.*
Cheirolepis Münsteri				×
42 *plants*	21	4	3+5	4+8

We have thus far found in the Mesozoic strata of Virginia forty-two species of plants sufficiently well preserved to be of some value in determining the age of the beds. Twenty-one of these appear to have no very near relations in the European floras. This large proportion, or 50 per cent., of species peculiar to Virginia, will be considerably lessened if we take into consideration the North Carolina plants and the plants found by Dr. Newberry and others in the older Mesozoic strata of Sonora, &c. But, as the age of this latter flora yet remains to be fixed, the plants common to it and the Virginia Mesozoic cannot be considered in any attempt to fix the age of the Virginia strata. This large proportion of species found in Virginia and not found in Europe is a noteworthy fact. Although we do not find specific identity in the case of any of these plants, yet we may get some hints as to their age from their generic characters and probable affinities. Taking up the list in order, then, we may note the following facts. We must omit, of course, the undetermined species of *Schizoneura.* It may be the cast of the interior of the *S. Virginiensis.*

We find two species of Acrostichides peculiar to Virginia, *A. microphyllus* and *A. densifolius.* It must not be forgotten that these two plants may not be Acrostichides, as their fertile fronds have not been found. There can, however, be little doubt, I think, that they are Acrostichides, for the two types of the sterile forms of Acrostichides are both represented in them, the rhombic type in *A. microphyllus*, and the oblong-ovate, subfalcate type in *A. densifolius*. *A. densifolius* has some features in common with *Pecopteris Haiburnensis*, Lind. & Hut., from the lower Oölite of Yorkshire. It has the same thin, membranaceous texture, and slender, copiously branched nerves, while the shape of the pinnules is something like that of the Oölitic plant. *A. microphyllus* might be compared with *Sphenopteris Rössertiana*, Presl, from the Rhætic of Germany. In any case these two plants belong to a type which is, in the main, characteristic of strata younger than the Trias.

Mertensides bullatus, by its fructification, belongs to the Gleicheniaceæ, and seems to have no very near relationship with any previously described plant. *Asterocarpus Virginiensis* also cannot help us in fixing the age of the strata containing it. The same may be said of *A. penticarpus*, as it is too fragmentary and poorly preserved to disclose with certainty its true character. *Pecopteris rarinervis* may be omitted for the same reasons.

The genus Cladophlebis is characteristic of the Rhætic and Jurassic. The five species of this genus not found in European strata, viz., *C. auriculata*, *C. ovata*, *C. microphylla*, *C. pseudowhitbiensis*, and *C. rotundiloba*, have a decided Jurassic facies, and some of the species would be placed by some authors in the group of *Alethopteris* or *Cladophlebis Whitbiensis*. The original *Pecopteris Whitbiensis* of Lindley & Hutton, and that of Brongniart, as it seems to me, if they are the same species, belong to the genus Cladophlebis, as Schimper has stated. Heer has taken the name *Whitbiensis* for certain species of Asplenites described from the Jurassic of Amur. It would seem that there is no warrant for assuming, as Heer has done, that the original species *Pecopteris Whitbiensis* is a species of Asplenites. The fructification of this plant has not been found, and until it is found it should remain in the genus *Cladophlebis*.

The small plant, *C. microphylla*, has some points in common with *Gleichenia Bindrabunensis*, or *Pecopteris gleichenoides* of Oldham & Morris, from the Rajmahal Group of India, but it is a larger plant. The number of species of Cladophlebis in the Virginia Mesozoic lends to the flora a Jurassic facies.

The two species of Pseudodanæopsis are more like the Triassic genus

Danæopsis than any other, yet the points of difference are very significant. Pseudodanæopsis is clearly, in its reticulated nervation, a higher type than Danæopsis, and this points to a later age for it.

The genus Ctenophyllum is characteristic of the Rhætic and Jurassic formations. The species *C. grandifolium* finds its analogues in the large Pterophylla of the Jurassic formation of India, of the type of *P. Footeanum.* The genus Podozamites is Rhætic and Jurassic. *Podozamites tenuistriatus* is more like *P. angustifolius* Schenk, of the Rhætic of Europe, than any other plant, while *P. Emmonsi* finds its nearest relatives among Oölitic forms. *Sphenozamites Rogersianus* is evidently one of the most complex of the species of this genus, which Saporta considers to be the highest in grade among the Cycadaceous plants. Sphenozamites is a Jurassic type. We find, then, that the generic character of the species peculiar to Virginia points strongly to a Rhætic and Jurassic age for these plants.

In the Triassic column of the table we find four species, or 9 per cent, that show some affinity with Triassic plants. These are *Schizoneura Virginiensis*, *Mertensides distans*, *Asterocarpus platyrachis*, and *Acrostichides rhombifolius.* Three of these show an equally close affinity with Rhætic forms. *Schizoneura Virginiensis* may be compared with *S. Meriani* of the Trias and *S. hœrensis* of the Rhætic, for both of these latter are probably the same species. *Mertensides distans* resembles *Pecopteris gracilis*, Heer, of the Trias, and also *Gleichenites microphyllus*, Presl, of the Rhætic. These two species are also probably the same. *Acrostichides rhombifolius* resembles *Neuropteris Schœnleiniana*, Schimp., of the Trias, and *Cyclopteris* pachyrachis of the Rhætic. We have, then, only one plant in the Virginia Mesozoic which has a greater affinity with a Triassic form than any other; this is *Asterocarpus platyrachis*, which is nearer *A. Meriani* than any other form. This degree of resemblance in the list is very small, and would be fully accounted for by the survival of plants of the Triassic flora.

Three identical, and five allied species, or 19 per cent., find their representatives in the Jurassic formation. The Jurassic element of this flora is, then, much stronger than the Triassic, even without counting the plants of Jurassic generic type found in the species peculiar to Virginia.

We find four species identical with Rhætic forms and eight allied to them, or 28 per cent. The Rhætic can, then, claim the largest percentage of identical and allied species. Among these we find some of the most abundant and characteristic forms of the Virginia flora. The great abundance and wide diffusion of *Macrotæniopteris magnifolia* and *Ctenophyllum Braunianum* give these plants especial weight. *Acrostichides linnææfolius* is very characteristic of the Virginia Mesozoic, and it finds its near relative in *A. Gœppertianus*, a plant highly characteristic of the Rhætic.

It is clear, then, from these facts that we must consider this flora as not older than Rhætic. The only question is whether or not its strong Jurassic features ought to cause us to regard it as at least Lower Liassic in age. I think that it is fully as much entitled to be regarded as of Liassic age as is the flora of the Rajmahal Group of India. Feistmantel and Zigno think that the age of this group is that of the Lias.

Taking everything into consideration, the flora of the older Mesozoic of Virginia is, of the European floras, nearest to that of Theta, near Bayreuth, in Franconia. It has elements which ally it with the plants found by Dr. Newberry at Los Bronces, Sonora, and it is also allied to the flora of Steierdorf, Banat, and to that of the Rajmahal Group in India, as well as that of Bjuf in Sweden. As we shall see, it is essentially the same with the flora of the Mesozoic strata of North Carolina, described by Dr. Emmons in his "American Geology," Part VI.

I append to the description of the flora of the Virginia Mesozoic a brief account of that of North Carolina. For the sake of greater clearness I think it best to give this under a distinct head, and to give in the plates copies of Emmons's figures.

PART III.

THE OLDER MESOZOIC FLORA OF NORTH CAROLINA.

For the sake of comparing the flora of the older Mesozoic strata of North Carolina with the plants from the beds of similar character in Virginia, I will give in the pages immediately following a brief account of it, taken from Emmons's American Geology, Part VI. I will give Emmons's description of each plant, using his own words, and then compare the described fossils with those from Virginia. It will be more satisfactory to give also the figures published by Emmons, and this I am permitted to do by his heirs. These figures were often drawn from very imperfect specimens, and the plants represented do not, in all cases, show their true nature until they are compared with more perfect specimens from Virginia. I would have preferred to examine the original specimens, but I find on inquiry that Dr. Emmons's collections of plants were destroyed during the late war. In this account I will omit certain obscure plants, such as Gymnocaulus, &c, as they have no fixed character and are very uncertain in nature. I would note that some mistakes seem to have been made in referring the descriptions to the plates and figures of Emmons's work, and plate 2, seems to have been omitted from the book, the figures being found on plate 6.

Most of Emmons's plants come from above the horizon of the Mesozoic coal-beds of North Carolina. Hence, if this coal be on the same horizon as the Virginia Mesozoic coal, as it probably is, most of the North Carolina plants must come somewhat higher up in the series of older Mesozoic strata than those from Virginia. Nearly all of the latter come from the beds immediately associated with the Mesozoic coal of Virginia.

Emmons gives the following plants as coming from the bituminous shale group that is associated with the coal-beds, viz.: *Equisetum columnaroides*, *Calamites punctatus*, *Walchia angustifolia*, and *Sphenopteris Egyptiaca.*

This bituminous shale group comes some distance above the base of the North Carolina Mesozoic series of strata, and, as stated, most probably stands on the horizon of the strata yielding most of the Virginia plants. It seems to be very poor in fossils. No determinable plants have been found under this group. The following is Emmons's description of the above-named plants. The plates first given in these descriptions refer to the plates of this work containing the plant in question. Figures given in Emmons's quoted descriptions are those of his work. The first and second of these plants are in Emmons's text referred to plate 2, but are really found on plate 6.

Equisetum Columnaroides.

Plate XLIX, Fig. 3.

Emmons's "Am. Geol.", plate vi, fig 3, p. 35.

"Cuticular surface very reticulate; articulations indistinct; ribs of the stem of two kinds, the ligulate and tapering; the latter terminate in a point, and are grooved in the middle. It belongs to the bituminous slate, near the top, and was found within the gray sandstone, beneath the main coal seam, and in the bituminous slates above."

I do not find plate 2, in the work of Emmons. In the description given above the reference is to plate 2, fig. 3, of the "Am. Geol." I find, however, on plate 6, fig. 3, the form depicted on Plate XLIX, Fig. 3, of this work and this may be the plant in question. It seems to be the same with the rhizome of *Equisetum Rogersi*, given on Plate I, Fig. 2, and found at Clover Hill.

Calamites punctatus.

Plate XLIX, Fig. 4.

Emmons's "Am. Geol.", plate vi, fig. 5, p. 35.

Emmons says of this:

"Stem finely striate; punctures, or bars, between all the striæ, sometimes on the striæ. The transverse bars, under a good glass, are much like dots, and do not always connect the longitudinal lines."

This plant is referred to plate 2, fig. 5, but I find it on plate 6, fig. 5. Its locality is not given. It is clearly a fragment of a leaf of *Sphenozamites Rogersianus.*

Walchia angustifolia.

Plate XLIX, Fig. 10.

Emmons's "Am. Geol.", plate 3, fig. 3.

"Leaves linear, or slightly lanceolate, and very narrow. All the specimens observed are small and imperfect. Fragments are frequently met with in the soft slates, but they have changed so much by weathering that the plant has become indistinct, It has been observed only in the Dan River Coal Field."

This small fragment seems to be a Cheirolepis very near to, if not identical with, *Cheirolepis Münsteri.*

Sphenopteris Egyptiaca.

Plate XLVIII, Fig. 8.

Emmons's "Am. Geol.", fig 8, p. 36.

Emmons's description is:

"Frond bipinnate, pinnæ decreasing slowly in length, elongate; pinnules smooth. thin, rather obtuse, lower lobes divided from the secondary rachis, but the others apparently attached, edges crenate, or in some instances apparently lobed."

It occurs only between the little or lower, and the main seam at Egypt, in the Deep River belt.

It is clear that this plant is not a Sphenopteris. It is closely allied to, if not identical with, the *Acrostichides princeps* of Schenk, "Flor. Foss. der Grenzsch," plate viii, fig. 1, differing from it only in being larger and in the somewhat more acute form of the pinnules. It has the same undulate margin and straggling nervation in the pinnules. In the absence of fructified pinnules, and on account of the greater dimensions of the plant, it should for the present be retained as a distinct species, and might be called *Acrostichides Egyptiacus.*

From this scanty list it will be seen that the bituminous slate group is remarkably poor in the remains of plants, and does not approach in richness the strata on the same horizon in the Virginia Mesozoic which at Clover Hill and elsewhere yield so many fine plants. I pass over without further mention the animal remains of this group, described by Emmons, which are not very rare and which are of great interest. I am unable to say what age would be indicated by them as a whole, but would call attention to the fact that if they should indicate an age somewhat older than that derived from the plants, this would be a condition of things similar to that found in the case of the Lignite Beds of the western portions of the United

States, where the horizon as derived from the animal remains is Cretaceous while the plants point to a Tertiary age.

Emmons states that the bituminous slate group is succeeded by gray and drab-colored thinly-bedded sandstones, which in some places attain a considerable thickness. Near Egypt, in the Deep River belt, these rocks are 1,200 feet thick. They are poor in fossils, containing only a few fucoids. This series is much concealed by the soil, and is exposed only to a very limited extent. The beds contain common salt diffused through them in small quantities. These rocks form the upper part of Emmons's Chatham series, and at Egypt they become red below the upper conglomerate or, No. 5. The change of color occurs sometimes lower down, and sometimes higher up. Up to the conglomerate No. 5, Emmons considers that his Permian strata or the Chatham series extend. As to the Permian age of these beds, I will say that the plants indicate that they are of the same age as the plant-bearing beds of the Virginia Mesozoic. The rocks overlying the Chatham series begin with a conglomerate. Emmons considers them to be of Triassic age.

The so-called Trias of North Carolina has, according to Emmons, the following order and character in its beds: 1. Conglomerate No. 5, alternating with beds of gray sandstone and blue, non-bituminous slate. The aggregate thickness on Deep River is about 40 feet. 2. Even-bedded gray sandstone, which is 300 to 500 feet thick at Haywood and other places in the Deep River belt. 3. Red, marly sandstone, which in some places is sufficiently hard and durable to make a building stone. It is at least 1,000 feet thick in the Deep River belt in Orange, Chatham, and Anson Counties. Towards the top of the series, according to Emmons, conglomerates become quite general. In Anson County there are heavy conglomerates near the close of this period.

This is the account given by Emmons of the strata above the upper conglomerate No. 5. I presume the conglomerates last mentioned are those to be found on the eastern side of the Deep River belt, and mentioned by Kerr as being very coarse and unconsolidated, in Wake County. Emmons states that the horizon yielding plants at Lockville and other points near by is at least 2,000 feet above the Coal Measures. He thinks that the upper group of strata, or that above the conglomerate **5**, is unconformable to that below this conglomerate. He gives the following plants from this upper group:

1. *Pecopteris falcatus.* Plate 4, figs. 5, 9.
2. *P. Carolinensis.* Plate 4, figs. 1, 2; fig. 68.
3. *P. bullatus*, Bunbury. Plate 6, fig. 8.
4. *Acrostichites oblongus.* Plate 4, figs. 6, 8.
5. *Tæniopteris magnifolia*, Rogers. Fig. 70.
6. *Neuropteris* spec.? Fig. 71.
7. *N. linnææfolia*, Bunbury. Plate 6, fig. 6.
8. *Cyclopteris obscurus.* Plate 4, fig. 10.
9. *Odontopteris tenifolius* (tenuifolius?). Plate 3, fig. 5.
10. *Walchia diffusus.* Plate 3, fig. 2.
11. *W. longifolius.* Figs. 72, 73; plate 4*a*.
12. *W. brevifolia.* Fig. 74.
13. *W. gracile.* Fig. 75.
14. *W. variabilis.* Fig. 76.
15. *Equisetum columnare*, Brongt. Plate 6, fig. 9.
16. *Calamites arenaceus*, Brongt. Figs. 77, 78.
17. *C. disjunctus.* Plate 4, fig. 4.
18. *Pachypteris?* Fig. 80.
19. *Cycadites acutus.* Fig. 81.
20. *C. longifolius.* Fig. 82.
21. *Podozamites lanceolatus*, Emmons. Plate 3, fig. 7.
22. *P. longifolius.* Fig. 83.
23. *Pterozamites decussatus.* Plate 3, fig. 1.
24. *P. pectinatus.* Fig. 84.
25. *P. obtusifolius* (*Zamites obtusifolius* Rogers). Fig. 85.
26. *P. gracilis.* Fig. 86.
27. *P. obtusus.* Fig. 86*a*.
28. *P. linearis.* Fig. 87.
29. *P. spatulatus.* Fig. 88.
30. *Dionites linearis.* Plate 4, fig. 11.
31. *Strangerites obliquus.* Fig. 89.
32. *S. planus.* Fig. 90.
33. *Pterophyllum robustum.* Figs. 91, 92.
34. Trunk of a cycad. Fig. 92*a*.
35. *Lepidodendron.* Figs. 93, 94.
36. *Albertia latifolia.* Fig. 95.
37. *Nœggerathia striata.* Fig. 96.
38. *Lepacyclotes ellipticus.* Fig. 98; plate 3, fig. 6.
39. *L. circularis.* Plate 3, fig. 4.
40. *Sphenoglossum* spec.? Plate 5, fig. 2.

Besides these he gives some fragments, which, as they do not appear to have any definite character, I omit in this list.

Pecopteris falcatus.

Plate XLVIII, Figs. 6, 7.

Emmons's "Am. Geol.", plate 4, figs. 5, 9, p. 100.

"Frond large, pinnate or bipinnate; secondary rachis smooth, channeled, leaflets long, rather distant than approximate, obtuse, falciform, and slightly prostrated at base, and adherent to the whole midrib; midrib distant (distinct?) to the apex; side veins go off at an acute angle, and fork once, and also twice; sori round and in two rows, with from 12 to 17 in a row. The standing of the leaves varies as to closeness. Occurs at Ellington's, 4 miles from Lockville. Fig. 5 seems to be closely allied to *P. falcatus*. It may be a barren frond. It might be denominated *P. falcatus* var. *variabilis*."

It is quite clear, I think, that the pinna depicted in Emmons's plate 4, fig. 5, is the sterile form of the plant whose fertile form is given in plate 4, fig. 9. The plant is probably a Laccopteris, and is near to *Laccopteris Münsteri*, Schenk, from the Rhætic of Europe, although it seems to be specifically distinct. It might properly be called *Laccopteris Emmonsi*.

Pecopteris Carolinensis.

Plate XLIX, Figs. 11, 12.

Emmons's "Am. Geol.", fig. 68, and plate 4, figs. 1, 2, p. 100.

"Frond, large pinnate; leaflets long, tapering beyond their middle, subacute, close, apices only seem to be free, slightly dilated at base; side veins going off at an acute angle, dividing once or twice. Fructification spots arranged singly and in a row on each side of the midrib, large, round, scolloped, radiate and elevated in the middle. Fig. 68 represents a leaflet enlarged. The leaflets of this fern are more than an inch long, thin and delicate, and they taper from near the middle to an obtuse point. Fragments only of this large fern have been found, some of which are 6 or 7 inches long. It might be mistaken for the preceding, the sori, however, are unlike it. Occurs at Ellington's."

I cannot understand why Dr. Emmons contented himself with giving only a single enlarged pinnule of this plant for the sterile form, and a small fragment of a fertile pinnule, when he had fragments 6 to 7 inches long. It is of course impossible with these figures to get any idea of the facies of the plant. It is clearly a Laccopteris, and most probably is identical with *Laccopteris elegans*, Presl. If not, it should be called *Laccopteris Carolinensis*.

Pecopteris bullata, Bunbury. p. 101.

Dr. Emmons copies Bunbury's figures, and gives his description of the plant, and refers it for its locality to the Richmond Coal Basin. He does not state whether it occurs in the North Carolina Mesozoic or not. We are thus left in doubt, as he may have merely given the description and figure for the sake of comparison and information. I shall hence include this plant in the North Carolina field doubtfully.

Arcostichites oblongus.

Plate XLIX, Fig. 1.

Emmons's "Am. Geol.", plate 4, figs. 6, 8, p. 101.

"Frond bipinnate; primary pinnæ going off at nearly right angles, prolonged and tapering; leaflets oblong, obtuse, close placed, and adherent by their whole base, which is slightly dilated; midribs rather faint, especially near the apex; side veins make rather an acute angle, anastomosing, but frequently fork towards the margin; primary rachis thick and straight."

Dr. Emmons seems to think that this plant may have been mistaken for *Peccpteris Whitbiensis*, though it is not clear why. He points out the differences, which are of course obvious. It is much like *Lonchopteris Virginiensis* in the general facies and shape of the pinnules, while the nervation is rather more lax in the central part of the pinnule, as given in Fig. 1 *a*. On account of the differences in the nervation, I hesitate to unite it with *Lonchopteris Virginiensis*, and suggest that it retain the specific name *oblongus*, whence the entire name would be *Lonchopteris oblongus*. It occurs at Ellington's.

Tæniopteris magnifolia, Rogers.

Emmons's "Am. Geol.", p. 102.

Dr. Emmons gives a figure of a fragment of this plant, which is the *Macrotæniopteris magnifolia* so common in the Richmond Coal Field. He says: "This plant is often, if not always, divided into segments down to the midrib as represented in the figure. Whether it is the result of accident, age, or is a part of its natural character, is not determined."

If this is a constant feature, as Dr. Emmons says it is, it could hardly be the result of accident. In the hundreds of specimens of this plant which have passed under my eye in the Virginia Mesozoic, though many of them were split and lacerated, yet this injury was never of a character to suggest that it was anything but the result of accident, and there was never the least regularity about it. The constant recurrence of the peculiar segmentation mentioned by Dr. Emmons strongly suggests the idea that the plant is not *Macrotæniopteris* (*Tæniopteris*) *magnifolia*, but rather a large Nilssonia or a Pterozamites like *Pterozamites Blasii*, Schimp., *Pterophyllum Blasii*, Schenk. I omit Emmons's figure, as it does not show anything definite.

Emmons gives in fig. 69, a frond which in outline exactly resembles the reduced form of *Macrotæniopteris magnifolia* given by Rogers in the "Trans. of the Am. Ass. of Geol.," &c., but the nervation is very different from that of *Macrotæniopteris magnifolia.* He says nothing about the figure, and hence I am at a loss to know its meaning. If it represents a plant found in the North Carolina Mesozoic, it is a new species. Locality not given.

Neuropteris. spec ?

Plate XLIX, Fig. 2.

Emmons's "Am. Geol.", fig. 71, p. 102.

"Frond large, bipinnate, secondary, as well as main rachis, thick and strong; leaflets obtuse, oblong, contiguous or adhesive by the whole base. This fern occurs at Ellington's. It is a very large plant, with a strong rachis. The side veins numerous, forked once or twice; it has no midrib towards the apex, or it vanishes about one-third its distance from the point."

This plant, I think, can hardly be separated from *Asterocarpus platyrachis* of the Virginia Mesozoic. It corresponds to the sterile form.

Neuropteris linnææfolia. Bunbury. p. 104.

Emmons merely copies a part of Bunbury's figure, and does not say that the plant occurs in the North Carolina Mesozoic, though it is to be presumed that it does.

Cyclopteris obscurus.

Plate XLIX, Fig. 5.

Emmons's "Am. Geol.", plate 4, fig. 10, p. 104.

"Frond suborbicular, sessile, veins numerous, three or four times divided, flexuous and radiate from the base. This Cyclopteris is imperfect, but there can be no doubt of its belonging to this genus. There are round dots like sori between the veins, but obscure, it may be by age. It occurs sparingly at Ellington's, and a smaller but different species occurs also at Lockville."

This plant is clearly a Sagenopteris. The figure represents two leaflets, partly preserved; the fragment on the left partly overlaps that on the right. It is much like the plant from the Richmond Coal Field, and there can be hardly a doubt that both are the very polymorphous Rhætic form *Sagenopteris rhoifolia.*

Undetermined Fern.

Plate LIV, Fig. 9.

On plate 4, fig. 3, of his work, Emmons gives a figure of a plant which he does not determine, and of which he says:

"On plate 4, fig. 3, I have introduced the figure of the apex of a frond which is not well defined, and hence it is uncertain to which genus of ferns it should be referred, provided it be a fern. No secondary veins can be seen, the midrib is plain, and the leaflets taper from the base to a point, and become decurrent upon the rachis."

This plant is precisely like the figure given by Schenk in his "Foss. Flor. der Grenzsch," plate viii, fig. 2, of *Asplenites Rösserti*, var., and it is probably the same plant.

Undetermined Fern.

Plate LI, Fig. 6.

On plate 6, fig. 2, of the "Am. Geol.", Emmons gives a figure of a plant which he does not determine, but of which he says:

"This is probably a Pecopteris, as its middle vein reaches the apex, and has forked side veins; but its characters are upon the whole too indistinct to be determined with certainty."

This is evidently a fragment of a young plant of a Laccopteris very close to, if not identical with, *Laccopteris elegans*. It much resembles fig. 2 plate xl, of Schimper's "Pal. Vég.," which represents the young sterile plant of *L. elegans*. I do not see how it can be separated from that plant.

Odontopteris tenifolius (tenuifolius ?).

Plate XLIX, Fig. 7.

Emmons's "Am. Geol.", plate 3, fig. 5, p. 105.

"Frond bipinnate, or pinnate-pinnatifid, leaflets membranaceous, adhering by the whole base, nerves springing from the secondary rachis in more than one set, branching forked. Found at Ellington's in the blue slate, but more rare at Haywood in the reddish marly slate. At the last locality the obscurity of the imprint creates considerable doubt respecting its characteristics. The imprints are numerous at this place, and the geological position far above that at Ellington's."

Emmons gives, in plate 3, fig 5, "Am. Geol.," the figure of a rather large plant, much resembling an Odontopteris. This, as seen in our Plate XLIX, Fig. 7, has no midrib or lateral veins given in the pinnules, but from the description of them the plant must be an Acrostichides, and it is probably identical with *Acrostichides rhombifolius* from the Virginia Mesozoic.

Emmons's figure much resembles some portions of the upper part of *A. rhombifolius.* On plate 6, fig. 1, "Am. Geol.," he gives a figure of a much smaller plant, which, although similar to an Odontopteris in facies, is probably a different species from that described above. This latter specimen, reproduced in our Fig. 9, Plate XLIX, is a good deal like some of the upper lobed pinnæ of *Acrostichides rhombifolius*, but it is more like *Sphenopteris Rössertiana*, Presl, from the Rhætic of Europe. It is much like *Sphenopteris obtusiloba*, Andræ, from the Lias of Steierdorf, which Schimper makes a Cladophlebis. These plants may prove to be Acrostichides, when their fructification is found. In the mean time, as it is probable that the North Carolina plant is not a Sphenopteris, it should be made a Cladophlebis If identified with the Liassic plant, as it probably should be, it ought to be called *Cladophlebis obtusiloba.*

It is to be noted that the horizon of this and the preceding plant is not the same. The blue slate alternates with the conglomerate, the basal rock of the upper series, and the reddish marly slate begins from 300 to 500 feet higher. It is much to be regretted that Emmons does not state which plant occurs at the lower, and which at the higher horizon. Probably it is the smaller plant, from its Liassic affinities, that occurs at the higher horizon.

Walchia diffusus.

Plate LI, Fig. 4.

Emmons's "Am. Geol.", plate 3, fig. 2, p. 105.

"Frond and branches thickly covered with small leaves, clasping at base, largest upon the main stem; branches numerous, irregularly placed, often elongated and very leafy; the leaves rather obtuse, and appear punctate under the microscope. The species is rather common at Ellington's."

Emmons seems not to have paid much attention to the structure of the leaves of the conifers from the North Carolina Mesozoic, and especially not to have noted with care their nervation, as in this case. Hence one cannot come to any very satisfactory conclusion concerning their true nature. In some of the leaves of this plant he has formed in the figure a midrib. If this be present, then the plant is a Palissya, as is indicated by the general facies. It is strikingly like *Palissya conferta*, Feist. Compare fig. 5, plate xlv, "Pal. Indica," series ii, 7. "Foss. Flor. of the Rajmahal

Group." The *Palissya conferta* is from the Rajmahal Group of India, which Feistmantel thinks is of Liassic age, but which contains so many Rhætic species that it appears to me to be of Rhætic age. At any rate the North Carolina plant does not seem to be a *Walchia*, and so long as it is not more precisely known, it is perhaps better to consider it as a distinct species which may bear the name *Palissya diffusa.*

Walchia longifolius.

Plate L, Figs. 1, 2; Plate LI, Fig. 1.

Emmons's "Am. Geol.", Figs. 72, 73; Pl. 4 *a*, pp. 105, 106.

"Plant shrub-like, or large and branching, stems striate, often nearly naked, the smaller leafy; leaves long, acute, keeled, clasping, and tapering from near the base, slightly decurrent. Fig. 72 shows the leafy branches. * * * Sometimes the branches appear to become naked, as in Fig. 73, and the termination appears of the form represented, as if it bore a cone more elongate than that of the Voltzia. This club moss is common at Lockville."

The above is the account given by Emmons of this plant, which is plainly a Palissya, and identical with the common Palissya of the Rhætic of Europe, viz., *Palissya Braunii*, Endl. This plant from North Carolina is precisely like the plant from India, from the Rajmahal Group, which Feistmantel calls *Palissya Indica*, and considers as a new species, though very near to *P. Braunii.* It seems to me that the differences are too slight to separate the India plant from *Palissya Braunii*, and that it is merely a slightly different form.

Emmons states that the leaves are keeled, that is, with one rib, but does not represent the rib or keel in the figures. This is an illustration of what was stated above of his neglect of the nervation of the leaves in his figures. He represents in his fig. 72, Pl. LI, fig. 1, of this work, three leafy branches of the plant as going off from a stout stem, but says that they were not actually seen attached to a stem. I have omitted the supposed main stem, and reproduce only the three branches, as these were all that were actually seen. The club-shaped mass at the summit of fig. 2, resembles strongly the cone of Palissya.

Walchia brevifolia.

Plate LIII, Fig. 3.

Emmons's "Am. Geol.", fig. 74, p. 107.

"Plant slender, elongated, branching, leafy; leaves rather short, lanceolate, acute, tapering towards the base. This plant has some resemblance to *Walchia hypnoides* of the Carboniferous system. Its leaves are scarcely larger, and are nearly of the same form. It occurs at Lockville. Some species (specimens ?) are 6 or 7 inches long, and appear as if the plant was procumbent."

It will be seen from this account that no definite information is given concerning the nervation and structure of the leaves. The plant appears to be a Cheirolepis, and may be a new species. It is, however, very near to the more slender forms of *Cheirolepis Münsteri*, Schimper, the forms that Schenk called *Brachyphyllum Münsteri.* I have but little doubt that it is identical with this plant.

Walchia gracile.

Plate L, Fig. 3.

Emmons's "Am. Geol.", fig. 75, p. 108.

"Stem procumbent, small, slender; leaves alternate, rather spatulate, and obtuse. This is a very small plant, and it is uncertain whether it should be regarded as a Walchia or not. The figure is twice the natural size. It belongs to the gray sandstone, 300 to 500 feet above the blue slate at Ellington's."

This appears to me to be merely a slender specimen of the above-described plant, viz., *Cheirolepis Münsteri.* The figure is twice enlarged.

Walchia variabilis.

Plate L, Fig. 4.

Emmons's "Am. Geol.," fig. 76, p. 108.

"Leaves lanceolate, acute, rather wide, grasping, decurrent. The leaves stand thickly upon the stem, but on different ones their width as well as length is variable, which may be due to compression, or the direction in which they have been compressed. The widest part of the leaf is about one-fourth of an inch from its apex, and its length from the base, in some of the leaves, is about half an inch. It has a resemblance to *Uncifolius,* but the leaves do not vary in size, as in the *Williamsonis,* neither are they hooked at their apices or unciform. The leaves when pressed laterally appear much narrower than when spread out naturally. It occurs at Turner's Falls, in the brownish flags, at least 500 feet above the second conglomerate."

There seems to be hardly a doubt that this plant is *Pachyphyllum peregrinum* (Lindl. and Hutt.), Schimper. Emmons says nothing about the texture of the leaves, but his figure indicates on some of them a sort of keel. *Pachyphyllum peregrinum* comes from the lower Lias of England, and is the *Araucaria peregrina* of Lindley and Hutton, depicted in the "Fossil Flora of Great Britain," plate lxxxviii. This plant from North Carolina comes, according to Emmons, as stated above, 500 feet above the horizon of the most common cycads of the North Carolina Mesozoic.

Equisetum columnare.

"This plant occurs in the Deep River formation, in obscurely marked specimens, in the thin-bedded gray sandstones at Ellington's, considerably above the blue slate."

This plant seems to be the same with *Equisetum Rogersi*, from the Virginia Mesozoic, and as it is a poor specimen and does not show any new features, I have not reproduced Emmons's figure.

Calamites arenaceus.

Emmons gives two figures, 77 and 78, of this fossil. As they represent the internal casts of *E. Rogersi* and show nothing new, I do not reproduce the figures. Emmons states that one specimen from the base of the stem was 4 inches in diameter.

Calamites disjunctus.

Emmons gives a figure of this internal cast on plate 4, fig. 4. It shows no characters that suffice to distinguish it as a new species, but may belong to Rogers's *Calamites planicostatus*, which appears to be a cast of a Schizoneura.

Echinocarpus.

Emmons gives a figure of a woody branching stem apparently, which he thinks is a dry seed vessel. It is merely a nondescript branching fragment, which has no characters that appear to be significant of anything but a branching stem.

Pachypteris.

Plate LI, Fig. 5.

Emmons's "Amer. Geol.," p. 112, fig. 80.

"Frond scarcely pinnate, leaves coriaceous, one-nerved, diminishing in width towards the base; long, oval, obtuse. The stem is strong, and the leaves should be regarded, perhaps, as alternating with one another. No side veins are discoverable, and the preserved leaflets appear distinctly coriaceous, with a single midrib."

The locality and horizon of this plant are not given. It is evidently not a Pachypteris, but is a conifer. It is apparently a Palissya with an unusually strong midrib. The remoteness of the leaves is no doubt due to the fact that many of them have been removed by the accidents that have befallen the specimen. It might bear the name *Palissya Carolinensis*.

Cycadites acutus.

Plate LI, Fig. 3.

Emmons's "Amer. Geol.," p. 114, fig. 81.

"Petiole strong, striate; leaves thick, narrow, rigid, acute, margins either revolute or thickened. This plant has leaves about 2 inches long, which spread nearly at right angles to the petiole. It occurs at Lockville, in the blue non-bituminous slate."

This plant is clearly a Cycadites, as Emmons has determined it to be. It resembles very strongly *Cycadites Roemeri*, Schenk, plate xi, fig. 1, "Foss. Flor. Nordwest. Weald.," from the Wealden of Germany. It is noteworthy that many of the plants from these upper strata strikingly resemble Wealden forms. Among those already mentioned, we have the following plants comparable to Wealden forms: *Cyclopteris obscurus* is not unlike *Sagenopteris Mantelli*, Schenk., "Foss. Flor. der Nord. Weald," plate x, fig. 5, while *Walchia brevifolius* may be compared with *Sphenolepis Kurriana*, and *Walchia gracile* with *Sphenolepis Sternbergiana*, Schenk, from the same formation. These resemblances, with others yet to be noted, are the more worthy of notice as I have found many Wealden plants among the uppermost beds of the border belts of the Mesozoic in Virginia. This *Cycadites* is very near to, if not identical with, *Cycadites Blanfordianus*, Old. & Mor., "Pal. Indica," series ii, plate ix, fig. 2. It may also be compared with *Cycadites longifolius*, Nath., "Bidrag till Sveriges Foss. Flora," plate xiii, figs. 1–3, from the Rhætic of Pälsjö, Sweden.

Cycadites longifolius.

Plate LI, Fig. 7.

Emmons's "Amer. Geol.," p. 115, fig. 82.

"Stem, or petiole, channeled; leaves opposite, thick, acute; margins thickened, and leaves standing at an acute angle with the petiole. This has a wider leaf than the former, and was probably a larger plant. The frond was probably 14 or 15 inches long, and the leaves 3 inches long. The specimen adheres to the rock by the back of the frond, and hence the midrib is indicated in this case only by a longitudinal channel. No side veins can be seen. The figure fails to represent the midrib. Occurs at Lockville."

Owing to the omission of the midrib in the leaflets, the facies of this plant is of course disguised. This is another of the cases where it is very desirable to see the original of the figure, in order to make out the true nature of the specimen, since Emmons's figure fails to give the true character.

Podozamites lanceolatus.

Plate LIII, Fig. 2.

Emmons's "Amer. Geol.," p. 116, plate 3, fig. 7.

"Stem, or midrib, strong, striate; leaves nearly opposite; lanceolate; nerves very distinct, and convergent to the apex. The detached leaves are very numerous in the slates at Ellingtons, and some are half an inch wide."

This plant is a true *Podozamites,* but not the *P. lanceolatus* of European authors. Hence, as this name is preoccupied, another must be chosen. It might be called *Podozamites Emmonsi.*

Podozamites longifolius.

Plate LIII, Fig. 5.

Emmons's "Am. Geol.," p. 116, fig. 83.

"Leaves linear-lanceolate, constricted immediately at the base, nerves fine, convergent. The *Podozamites lanceolatus* and the *P. longifolius* differ. In the latter the nerves are much finer, and the leaves narrower in proportion to their length, and less constricted at base, and hence it is possible that it should be transferred to another genus. The frond is 7 inches wide, and was probably 2 feet long. The portion of the frond obtained was about 9 inches long. Its leaf was thinner than the *Cycadites longifolius.*"

This plant is evidently not a Podozamites, and to judge from the figure the leaflets were not constricted at base, or but slightly so on the upper side, while they are decurrent on the lower side. The nerves do not appear to be convergent. It seems to be a Dioonites, and is much like Dioonites *Humboldtianus* (*Pterophyllum Humboldtianum,* Dunker) from the Wealden of Germany, which Schimper makes a Dioonites. The midrib, however, of the North Carolina plant is much smaller, and the leaflets wider than the corresponding parts of the Wealden fossil. It is probably nearly allied to the plant from the Rajmahal Group of India, figured on plate xli, figs. 1 and 2, "Pal. Indica," series ii, 7, which Feistmantel calls *Zamites proximus.* It closely resembles this plant, but the leaflets are wider and the midrib stouter. The *Zamites proximus* seems to be a true Dioonites.

Pterozamites decussatus.

Plate LI, Fig. 2.

Emmons's "Am. Geol.," p. 117, plate 3, fig. 1.

"Frond pinnate; petiole strong, striate; leaves long, obtuse, many nerved, and standing at right angles with the petiole, and rather wide. It occurs at Ellington's in the blue slate."

This plant is evidently a Pterophyllum of the type of *Pterophyllum Jægeri.* It seems to be closely allied to *Pterophyllum æquale,* Nathorst, from the Rhætic of Sweden. Compare figs. 6, 8, 10, plate xv, "Floran vid Bjuf." The tips of the leaflets do not seem to be preserved in the specimen figured by Emmons. It may be called *Pterophyllum decussatum.*

Pterozamites pectinatus.

Plate LIII, Fig. 4.

Emmons's "Am. Geol.," p. 117, fig. 84.

"Leaves narrow, many nerved, and standing at right angles to the strong midrib. Occurs at Lockville in the blue slate."

This plant bears a strong resemblance to *Pterophyllum Lyellianum* Dunker, from the Wealden of Germany; at least it resembles the forms of that plant with narrow leaflets. Compare Schenk, "Foss. Flor. der Nord. Weald.," plate xiii, fig. 1, and Dunker, "Monographie der Nord. Weald.," plate vi, figs. 1, 2. It is, however, apparently a new species, and may be called *Pterophyllum pectinatum*, for it is clearly a true Pterophyllum.

Pterozamites obtusifolius (Zamites obtusifolius Rogers.)

Plate LIV, Fig. 4.

Emmons's "Am. Geol.," p. 118, fig. 85.

"Midrib straight, tapering to the end of the pinna, striate; leaflets attached by their whole base, and nearly in contact, and standing upon the stem at angle of about 80°. Pinnules have from 3 to 6 parallel veins."

Emmons goes on to say of this plant:

"I have observed many specimens at Haywood which agree in size and other characters with the foregoing. Generally the apex of the leaflet is rounded off in the same manner, but in some specimens it is more tapering, and may appear more acute. In others still, which perhaps should be referred to this species, the leaflet is about one-tenth of an inch wide, and preserves this width to near the apex, and the leaves are also shorter. Fig. 85 [Plate LIV, Fig. 4, of this work] is an example of a common form. The figure is taken from the middle of a frond."

He seems to be uncertain whether to refer the plant to Rogers's *Zamites obtusifolius* or not, stating that they frequently appear to run into each other.

The plant in question is clearly the var. β, or the form with short leaflets of *Ctenophyllum Braunianum* Goepp., from the Rhætic of Franconia. Compare figs. 1, 2, plate xxxviii, Schenk, "Foss. Flor. der Grenszchichten." Emmons does not give the exact horizon at Haywood on which the plant is found. From his remarks it would appear that the fossil is abundant. We thus have in North Carolina and in Virginia both varieties, and in abundance, of this plant which is so highly characteristic of the Rhætic formation.

Pterozamites gracilis.

Plate LIV, Fig. 5.

Emmons's "Am. Geol.," p. 118, fig. 86.

"Frond tapering very gradually to the apex, leaflets oblique to the midrib, linear rounded, and obtuse at their extremities. The frond is about 5 inches long, and in this, as in most of the species, they [the leaflets?] stand nearly opposite to each other. This plant resembles *Zamia taxina*, but is more delicate."

It is clearly only a smaller form of the preceding or *Ctenophyllum Braunianum* var. *β*. No locality and no horizon are given for it by Emmons, but it is to be presumed that it occurs with the preceding plant.

Pterozamites obtusus.

Plate LIV, Fig. 1.

Emmons's "Am. Geol.," p. 119, fig. 86*a*.

"Frond very obtuse; stem slender; leaflets distinctly nerved, and rather narrowed towards the base. The leaf has about 16 or 17 nerves, and they preserve these [their?] lengths to the apex of the stem, which gives it an obtuse or broad termination. It occurs at House's Quarry."

This plant is a Ctenophyllum of the type of *Ctenophyllum imbricatum* (Ett.) Schimp. from the Lias of Steierdorf, Banat. It is, however, a larger plant, and is most probably a new species. I would have no hesitation in uniting it with the *Pterophyllum robustum* of Emmons, to be described presently, but for the notable difference in the number of nerves in the leaflets, 16 or 17 in this plant, against 8 or 9 in the case of the *P. robustum.* It is possible that Emmons may have mistaken the number of nerves in the latter, for sometimes, in certain modes of preservation of the leaflets, and perhaps in their original form, nerves which normally appear distinct are consolidated so as to give a number of strong nerves equal to half the number of the normal finer nerves. This would seem to be the explanation of the variable number of nerves seen in *Ctenophyllum Braunianum*, viz., 6 or 7 fine nerves, and sometimes only 3 strong ones. As we cannot be certain about the nerves of this plant, it will be best to retain it as a distinct species, with the name *Ctenophyllum Emmonsi.*

Pterozamites linearis.

Plate LIV, Fig. 2.

Emmons's "Am. Geol.," p. 120, fig. 87.

"Frond linear and narrow; leaflets very narrow and delicate; midrib slender. It occurs in the soft drab-colored slate at House's Quarry, Haw River."

This plant is clearly a Ctenophyllum. It is possible that it may be a small form of the very variable *Ctenophyllum Braunianum*, but it seems to be a new species. It might be called *Ctenophyllum lineare.*

Pterozamites spatulatus.

Plate LIII, Fig. 6.

Emmons's "Am. Geol.," p. 120, fig. 88.

"Midrib delicate, punctate or transversely striate, leaflets long, spatulate, or narrowing towards the base, but attached by their whole width. The termination of the leaflets is rounded, and they are widest near the middle or a little beyond it. It occurs at House's Quarry, on the Haw River."

The only plant known to me with which this may be compared is the *Pterophyllum Andrœanum*, Schimper, *Pterophyllum longifolium*, Andrae, from the Lias of Steierdorf, Banat. But this latter plant has wider leaflets that are joined at the base. Still, Andrae's figure 1, plate x, of the "Foss. Flor. Sieb. und des Banates," shows that some of the leaflets of the Steierdorf plant are not wider than those of the North Carolina species. The Steierdorf fossil in this irregularity of the width of the leaflets on the same midrib resembles the Virginia *Pterophyllum inœquale.* The Steierdorf plant has the same narrowing of the leaflets towards the lower part that we find in the North Carolina plant. Taking these three forms together, viz., *Pterophyllum Andrœanum*, *P. inœquale*, and the present plant, *P. spatulatum*, we have a complete transition from one form to the other, and, assuming that the North Carolina and Virginia fossils form the extremes, the Steierdorf plant is the intermediate form. The plant in question is clearly a Pterophyllum, and may be called *P. spatulatum.*

Dionites linearis (Zamites graminoides).

Plate XLIX, Fig. 6.

Emmons's "Am. Geol.," p. 121, plate 4, fig. 11.

"Frond narrow, pinnate, elongate; midrib slender, striate; leaves long, narrow grass-like, tapering from near the middle to a point, and forming an acute angle with the midrib. This plant differs from the *Zamites graminoides* of Professor Bunbury in the length and width of the leaves, being shorter and not as wide. The longest are about $1\frac{1}{4}$ inches long, and have about 6 delicate nerves. The leaves are rather less than one-tenth of an inch wide."

Emmons does not give the locality and horizon of this plant. I do not understand the dimensions given. The longest leaflets of the figure are $1\frac{1}{4}$ inches (= 3 centimeters) long, and it is plain that these are mere fragments of leaflets. However, the length would depend upon the part of the leaf which yielded the specimen. The *Zamites graminoides* of Bunbury above referred to is probably *Zamites gramineus*, which Bunbury, in his paper on the fossil plants from Eastern Virginia, doubtfully considers a new species, being not sure that it is different from Rogers's *Zamites obtusifolius*. From Bunbury's description of *Z. gramineus*, it differs from Rogers's plant only in having the leaves longer and more slender. There is no doubt that the plant in question from North Carolina, and those of Bunbury and Rogers, are parts of the polymorphous *Ctenophyllum Braunianum*, var. α. The North Carolina specimen seems to be from the upper part of the plant, and hence the obliquity of the insertion of the leaflets.

Strangerites obliquus.

Plate LIV, Fig. 8.

Emmons's "Am. Geol.," p. 121, fig. 89.

"Frond robust, nerves or side veins very numerous, and go off at an acute angle, and soon form an obtuse one with it, dividing once or twice, once near the midrib and again near the margin. The average breadth of the frond is three-fourths of an inch, and its margin is undulating."

The figure plainly shows that the margin is not preserved, the undulation being due to the peculiar mode of laceration. The singular nerves, some of which stop short in the leaf before reaching the margin, attain this appearance, no doubt, from the fact that Emmons studied the nervation only in a single imperfect specimen. The figures of a good many of Emmons's plants seem to show that the nervation and other minuter details were obtained from single specimens, of which, apparently, fac-similes were given, imperfections and all. The nerves of this plant in many cases, if continued in the course they pursued when they suddenly stopped short, would anastomose with their neighbors. This fact, with the open character of the lateral nerves, and the broad, flat midrib, make it clear, I think, that the plant is the same with *Pseudodanœopsis nervosa*, from the Virginia Mesozoic.

Strangerites planus.

Plate LIV, Fig. 3.

Emmons's "Am. Geol.," p. 122, fig. 90.

"Frond even, smooth; midrib narrow and gently tapering to a point; side veins dividing once, twice, and even three times. This species differs from the former in being much longer and having a thinner midrib. Its leaf is also thinner and more delicate, with a very uniform and even margin. Both species are found in the blue slate at Ellington's, above a thick bed of conglomerate."

Here again the nerves are made to stop short within the leaf, without attaining the margin, when by continuing them they would anastomose with their neighbors. From the narrow pinnules, the sharply-defined midrib, and the fine nervation, it is clear that this is *Pseudodanœopsis reticulata.*

Pterophyllum robustum.

Plate LIV, Fig. 7.

Emmons's "Am. Geol.," p. 122, fig. 91.

"Midrib thick and stout, striate; leaflets short, linear, imbricate; side veins distinct (and parallel). The leaflets preserve a uniform width to the end, and terminate bluntly; they have 8 to 9 veins each. This Pterophyllum occurs in a drab-colored sandstone, 300 to 400 feet above the blue shale at Ellington's, and immediately above a gray conglomerate, and 50 to 100 feet above this the red marly sandstone occurs."

This appears to be a well-defined new species of Ctenophyllum of the type of *Ctenophyllum imbricatum.* But for the less number of nerves I should think it identical with *Ctenophyllum Emmonsi*, previously mentioned. According to Professor Lesquereux, this plant occurs in the Mesozoic of Pennsylvania, at Phœnixville.

Pterophyllum robustum, var.?

Plate LIV, Fig. 6.

Emmons's "Am. Geol.," p. 123, fig. 92.

"Midrib rather thin and slender; leaflets short, about 8 ribbed or nerved; leaf rather thin and not imbricated. It appears to be the termination of the frond of *P. robustum.* This occurs with the preceding."

It is clearly the termination of the leaf of the preceding plant.

Trunk of cycad.

Plate LII, Fig. 5.

Emmons's "Am. Geol.," p. 123, fig. 92 *a*.

"The scars of the fallen leaves are rhomboidal, and the center of each has a rhomboidal pit. There is a tendency to striation immediately upon the border of each scar."

This is apparently a Zamiostrobus, and not the trunk of a cycad. It might be called *Zamiostrobus Emmonsi.* Emmons says that he found in the same bed cylindrical casts with a rough exterior, but no distinct marks of fallen leaves, which were no doubt casts of the trunks of cycads. He does not give the locality and horizon of these impressions.

Lepidodendron.

Plate LIV, Fig. 10.

Emmons's "Am. Geol.," p. 124, fig. 93.

"The cast of trunks bearing the external markings of this singular vegetable are by no means common, but many smooth and rather striate stems, 7 to 8 inches in diameter, are very common at House's Quarry, on Haw River. In one instance I obtained a branch marked and scarred as in figure 94. Fig. 93 (Fig. 10 of this work) was taken from the cast of a stem imbedded in the conglomerate of Lockville. The stem was 6 or 8 inches long, and had a small branch proceeding from it."

I omit Fig. 94, as it is too vague to show anything of the true nature of the impression, which was evidently a Zamiostrobus, and possibly the same with Z. *Emmonsi.* Emmons's fig. 93 (Fig. 10 of this work) might represent a new species of Zamiostrobus but for the great length mentioned above by Emmons, viz., 6 or 7 inches.

These impressions are of course not those of Lepidodendron, as this plant does not exist in the Mesozoic.

Albertia latifolia.

Plate LII, Fig. 6.

Emmons's "Am. Geol.," p. 126, fig. 95

"The leaves are thin and broad, scarcely striate, ovate, or obovate, and subspatulate or narrowed at the base and apparently slightly decurrent. Separate leaves of this plant are not uncommon in the beds at Lockville. The leaves are pressed obliquely sometimes, and hence true forms may not be accurately preserved. Occurs in the blue sandy slate or shale at Lockville."

I think there can be little doubt but that this plant is an Otozamites of the type of *Otozamites Beanii*, Schimper (*Cyclopteris Beanii* Lindl. and Hut.), from the Oölite of England. This plant may be compared with the narrower leaflets of the English fossil, those coming from the upper part. It is, however, a new species if it be an Otozamites. It would require an examination of the original specimen to decide this point. The plant figured by Emmons is evidently fragmentary and the leaves a good deal distorted, as he suggests. The left-hand lower leaf, only partially preserved, must originally have been in shape and size near the larger leaflets of *Otozamites Beanii*, and have overlapped in part the leaflet above. Though the character of the plant is not clearly disclosed by the figure, it would appear that it cannot be an *Albertia*. The nerves, as drawn in the figure of Emmons, are represented as forking near the margin of the leaflets in a manner similar to that seen in the nervation of the leaflets of Otozamites. It may be called *Otozamites Carolinensis*

Nœggerathia striata.

Plate LIII, Fig. 1.

Emmons's "Am. Geol.," p. 127, fig. 96.

"The leaves are coarsely striate. It occurs in a light-greenish shale, about 5 miles north from Haywood. It is very nearly upon the parallel (horizon?) with the beds upon Haw River, which furnish so many Cycads and Calamites."

This is clearly the basal portion of *Baiera multifida*.

Emmons gives in fig. 97 a nondescript plant which he calls *Comephyllum cristatum*. As it does not show any characters that throw light upon the nature of the plant I omit it.

Lepacyclotes ellipticus.

Plate LII, Fig. 4.

Emmons's "Am. Geol.," p. 129, fig. 98.

"Disk elliptical, scales attached to an elliptical nucleus; disk supported by, or attached to, a stem which passes through the middle in the direction of its long axis. The number of scales in the disk is from 20 to 24. The stem is not always visible."

This plant is evidently a cone of a conifer near to Araucaria. Indeed the resemblance is so great that it may well be a true Araucaria. The supposed stem appears to me to be accidentally present. The figure represents the base of the cone as it would appear when mashed flat in the direction of its longer axis. Fig. 4 *a* represents two scales of the cone now in question.

Lepacyclotes circularis.

Plate XLIX, Fig. 8.

Emmons's "Am. Geol.," p. 130, plate 3, fig. 4.

"Disk or circle formed of scales as in the preceding, but they appear to radiate from its center. In this specimen a dark-colored flattish or circular body is connected to the central termination of the scales, which may have been the fruit or seed. Portions broke from it when detached from the rock, leaving the overlying body as represented in the figure. Another species occurs in the sandstones above, associated with Pterophyllums. There are certain facts connected with this plant which are not rationally explained on the natural supposition that they are analogous to the cones of pines, for the same species of disks with their scales occur which are less than half an inch in diameter, and in another instance the disk is formed of three concentric tiers of scales, the center one similar to the figure given above, but the outer one bordering it, formed of shorter scales. It is 7 inches in diameter, and another formed of a single row of scales is 5 inches in the longest diameter. They are found at Ellington's in the soft blue slate above the conglomerate. The detached scales are very numerous. Only one specimen has been obtained at Lockville."

I do not see any reason in the above account to deny the coniferous character of these bodies, but rather find reasons for assuming that they are cones. There may be several species, but the *L. circularis* is clearly the same with *L. ellipticus*, the latter being slightly distorted by pressure. The plant may be called *Araucarites Carolinensis.*

Undetermined plant.

Plate LII, Fig. 2.

Emmons's "Am. Geol.," p. 131, fig. 99.

Fig. 99 of the "American Geology" depicts a singular form, of which Emmons says:

"It is the most common plant of the blue shale at Lockville. The stem is flattened, but retains its parallel and obscure striæ, which are continued upon the leaves. The length of the leaf is remarkable, and, considering that they do not diminish in breadth along the space through which they have been uncovered, they must be from 12 to 18 inches long. Their breadth varies from one to five lines, and they never taper. Five leaves in one instance proceed from the stem as represented in the figure. The stem is nearly a line thick, and hence had more substance than the Equisetaceae or Calamites."

I have, in the shales of the Clover Hill deposits, often seen obscure branching forms not unlike the plant depicted here. They were evidently succulent, and had the nature of stems, not of leaves. I have considered them to be rhizomes of some plant which spread and ramified in the soft mud of the period. This plant of Emmons is evidently stem-like, with branches. I cannot offer any explanation of its true nature. The Virginia specimens, the only original ones that I have seen, are even more vague than Emmons's plant.

Another peculiar plant is given by Emmons in fig. 100 (Plate LII, Fig. 1 of this work). He says:

"It occurs in the slate at Lockville. It is a simple strap-like leaf, which is finely striate. The specimen from which the drawing was taken was about 14 inches long, and broken at both ends. It is smooth, or under the microscope appears finely striate."

Another plant apparently of the same nature, which, as it appears to me, has accidentally superposed upon it a fragment of stem, is given by Emmons in fig. 101. Emmons thinks that the apparent stem is a real one. Both this and the preceding plant appear to be leaves of a grass-like form, perhaps of the kind named Bambusium, but without the originals it is impossible to come to any definite conclusion about them. For convenience of reference they may be denominated *Bambusium Carolinense.* Still another undetermined plant is given by Emmons in fig. 102 (Plate LI, Fig. 8 of this work). This, Emmons says, "resembles *Baiera gracilis*, or the plant referred to *Baiera* doubtingly by Professor Bunbury in the 'Quarterly Journal Geological Society.'"

This is clearly a Baiera, much smaller than the *Baiera multifida.* I have not seen Bunbury's figure, and hence cannot verify Emmons's comparison of it with Bunbury's plant. The plant now in question is much like *Baiera Münsteriana*, Sap., or *Jeanpaulia Münsteriana*, Ung., from the Rhætic of Germany, and is no doubt the same plant. This plant, formerly called *Jeanpaulia*, is now considered by Saporta and Heer to be a Baiera.

Sphenoglossum quadrifoliatum.

Plate LII, Fig. 3.

Emmons's "Am. Geol.," p. 134, plate 5, fig. 2.

"Leaves short, wedge-formed, or subtriangular, marked with striæ radiating from the center, arranged in twos or fours around the stem or support. The leaves have divergent margins, and are marked with unequal or divergent lines. Stem quadrangular? Many specimens were found in the upper marly sandstone, some single, some in two, and others with three leaves, and the base of the fourth. One of the latter is therefore restored in the figure. Mr. Lea, of Philadelphia, has a similar plant from Turner's Falls, Mass., but this has two opposite leaves only."

The only fossil plant that I can compare this curious form to is the *Actinopteris peltata* of Schenk, "Foss. Flor. der Grenszchichten, &c.," plate vi, figs. 3, 4, 5, from the Rhætic of Germany, where it is abundant. Schenk's forms appear to be circular, single leaves, though on some of them there appear faint indications of a segmentation. Schimper says of these impressions that they are not plants, but dendritic infiltrations of hydrated oxide of iron around bits of carbonized matter. This may be true of the European impressions, and the explanation may suffice for circular markings, but it is not easy to see how infiltrations could take the form of regular wedge-shaped segments, with well-defined margins, as in the North Carolina markings. Feistmantel, on plate xi, figs. 1, 2, "Pal. Indica," series xi, 1, "Oölitic Flor. of Kach," gives figures of forms which closely resemble the North Carolina specimens, and which are clearly segmented in a similar manner, but which show five and six wedge-shaped segments. Feistmantel, with Schimper's explanations before him, states that he has a form from the Raniganj Coal Field, which proves that this impression really belongs to a fern. We may then conclude that the plants in question from North Carolina are perhaps ferns, and probably of the genus *Actinopteris*. They might be called *Actinopteris quadrifoliata.*

GENERAL REMARKS AND CONCLUSIONS.

I have now given all the significant forms mentioned by Emmons from the Mesozoic of North Carolina, with his descriptions of them, and with my conclusions respecting them.

It is not necessary to dwell upon the character of the strata of the two North Carolina areas. It is evident that they have a close resemblance to each other and to the Mesozoic beds of Virginia. The physical and stratigraphical resemblances are sufficient, without the evidence of the plants, to indicate that the North Carolina and Virginia Mesozoic strata are of the same age, and that they were formed under similar conditions. In both States we have at the base of the formation barren strata, followed by carbonaceous strata, and at the summit barren strata again, while in many minor points the resemblance is striking.

The following is the list of plants from the North Carolina strata according to my determinations. They may be put in the form of a table, showing the plants peculiar to North Carolina, those found in the Virginia Mesozoic, and those either found in the Triassic, Rhætic, and Jurassic of foreign lands, or having affinities with the plants of these formations.

Fossil Plants from the Older Mesozoic of North Carolina.

Mesozoic plants from North Carolina.	Peculiar to North Carolina.	Found in the Virginia Mesozoic.	Found in the Trias of other countries.	Found in the Jurassic of other countries.	Found in the Rhætic of other countries.
Equisetum Rogersi		×		Near to *E. columnare*.	
Acrostichides Egyptiacus					Near to *A. princeps*.
A. linnææfolius		×			Near to *A. Goeppertianus*.
A. rhombifolius		×			Near to *Cyclopteris pachyrachis*.
Laccopteris Emmonsi					Near to *L. Münsteri*.
L. Carolinensis					Near to *L. elegans*.
L. elegans					×
Mertensides bullatus		×			
Lonchopteris oblongus		Near *L. Virginiensis*.			
Macrotæniopteris magnifolia		×			Near to *M. gigantea*.
Asterocarpus platyrachis		×			Near to *Pecopteris concinna*.
Sagenopteris rhoifolia		×			×
Asplenites Rösserti					×
Cladophlebis obtusiloba				×	
Pseudodanæopsis nervosa		×			
P. reticulata		×			
Actinopteris quadrifoliata					Near to *A. peltata*.
Sphenozamites Rogersianus		×			
Otozamites Carolinensis	×				
Dioonites longifolius				Near to *Zamites proximus*.	
Podozamites Emmonsi		×			
Ctenophyllum lineare	×				
C. Braunianum, var. α		×			×
C. Braunianum, var. β					×
C. Emmonsi				Near to *Ctenophyllum imbricatum*.	
C. robustum	×				
Pterophyllum decussatum		×		Near *P. andræanum*	
P. pectinatum					Near to *P. æquale*.
P. spatulatum	×				

Fossil Plants from the Older Mesozoic of North Carolina—Continued.

Mesozoic plants from North Carolina.	Peculiar to North Carolina.	Found in the Virginia Mesozoic.	Found in the Trias of other countries.	Found in the Jurassic of other countries.	Found in the Rhætic of other countries.
Cheirolepis Münsteri		×			×
Palissya diffusa				Near to *Palissya conferta*.	
P. Braunii					×
P. Carolinensis	×				
Cycadites acutus				Near to *Cycadites Blanfordianus*.	
C. longifolius	×				
Pachyphyllum peregrinum				×	
Baiera multifida		×			
B. Münsteriana					×
Araucarites Carolinensis	×				
Zamiostrobus Emmonsi	×				
Bambusium Carolinense	×				
40	9	15 + 1		2 + 6	7 + 8

From this list we see that thirty-nine species, omitting the *Bambusium*, may be determined, with some degree of reliability, from the Mesozoic of North Carolina. An analysis of the list shows that nine species are peculiar to North Carolina, and have no very near allies in other countries. Fifteen species are found in the Virginia Mesozoic, and one is closely allied to a Virginia plant, for the *Lonchopteris oblongus* may really be identical with *L. Virginiensis.* Assuming, with Feistmantel, that the Rajmahal Group of India is of Liassic age, we have two species identical with, and six nearly allied to Jurassic plants, while seven species are identical with, and eight closely allied to Rhætic plants. If we put these relationships in the form of percentages, we find that 23 per cent. of the plants are peculiar to North Carolina, 41 per cent. are found in Virginia, 20 per cent. are allied to, or identical with Jurassic forms, while the number of forms identical with, or allied to Rhætic plants amounts to 38 per cent. Among the species allied to, or identical with Virginia plants we have some of the most abundant and characteristic species, such as *Equisetum Rogersi*, *Macrotæniopteris magnifolia*, *Acrostichides linnææfolius*, *A. rhombifolius*, *Mertensides bullatus*, *Baiera multifida*, &c. Judging, then, from the evidence of the fossil plants, the Mesozoic of North Carolina is of the same age with that of Virginia.

If we compare the plants common to North Carolina and Virginia with the plants peculiar to each State, certain facts become prominent. The North Carolina strata are much richer in conifers than those from Virginia, both in the number of individuals and in species. This is, I think, due to the accidents of preservation. Most of the North Carolina plants come from a horizon where the strata indicate disturbances of level, abundant sedimentation, and the ingress of rivers. It will be noted that by far the richest flora is that found in the blue shales intercalated in the upper conglomerates, or No. 5 of the series of beds. These shales were accumulated in pauses of the more violent action which produced the conglomerates, and would of course be very favorable for the reception and preservation of plants swept off the higher parts of the land, where conifers would grow. We have no plants in the Virginia Mesozoic from this horizon.

Another fact worthy of note is the great rarity of plants from the coal-bearing portion of the North Carolina Mesozoic, while nearly all of the plants from the Virginia Mesozoic come from the strata associated immediately with the coal. While the vertical distance apart of the horizons yielding plants in the two States is perhaps not sufficient to cause any considerable change in the flora, the conditions that prevailed when the strata of the two horizons were laid down were undoubtedly different, and easily account for the differences that prevail in the kinds of plants preserved in the two States. The North Carolina plants come, with three or four exceptions, from the upper strata which were accumulated, as above stated, in waters no doubt in an unquiet state and loaded with sediment. We find, then, in these strata comparatively few ferns, but many conifers and cycads, plants that did not grow in the marshy grounds of the lakes, or on their swampy shores, but were to be found on higher ground, and hence had to be transported some distance in order to reach the sediment that preserved them. On the other hand, the Virginia plants all come from the horizon of the coal where the sediment was slowly accumulated, and where the waters were still and received few remains of plants besides those that grew in the mud and on low or marshy grounds. We find accordingly in the Virginia beds almost no conifers, but few cycads, and an immense number of individuals of one species of Equisetum, with quite a large number of species of ferns. These important differences in the conditions of preservation, without doubt, lessened the number of identical species in the two States, which number was, no doubt, much greater than it appears to be from the number of preserved species.

It will be noted that I have placed in the Triassic column no species, although the age of both the North Carolina and Virginia Mesozoic is held by many to be Triassic, largely on the evidence of the plants. It will be necessary, then, carefully to examine whether or not there is any such evidence of Triassic age.

On examining the list of names employed by Emmons, we meet with several which if correctly determined would indicate a Triassic or Permian age for the Mesozoic beds. The plants of this kind are the following: *Calamites arenaceus*, the several Walchias, *Pterozamites decussatus*, *Albertia latifolia*, *Nœggerathia striata.* Professor Heer, in some notes on Emmons's plants, published in the "American Journal of Science and Arts," November, 1857, considers *Pecopteris bullata* (*Mertensides bullatus* of this memoir) to be nearly allied to *Pecopteris Stuttgartensis* (*Lepidopteris Stuttgartensis* of Schimper) from the Trias of Europe. I have included in the above list Emmons's *Pterozamites decussatus*, because Professor Heer expressed the opinion that it might be *Pterophyllum longifolium* of the European Trias.

The *Calamites arenaceus* of the above list is merely the internal cast of *Equisetum Rogersi*, which is nearer *Equisetum columnare* than any other foreign plant. Even were it more closely allied to *Equisetum arenaceum*, this would not compel us to place it wholly among Triassic plants, for Saporta has shown, in "Pal. Française," "Plantes jurass.," that this Equisetum goes up into the base of the Rhætic in France. *Pterozamites decussatus*, or *Pterophyllum decussatum*, is more nearly allied to *Pterophyllum Andrœanum*, Schimp., from the Lias of Sweden, than to any other plant. The Nœggerathia and the Walchias would indicate a Permian, and not a Triassic age. As to the Permian age of the beds, no one will maintain it now. The Nœggerathia is the basal portion of *Baiera multifida*, a plant perhaps without very near affinities with any previously described ones, but which is nearer to *Baiera* *tæniata*, Braun, of the Rhætic of Europe. The so-called Walchias are not true Walchias. In the absence of the originals, and with only the imperfect figures of Emmons before me, I freely admit that my determinations are doubtful. The only one of these plants, judging by the figure, that might be taken for a Walchia is the *W. diffusus* of Emmons, *Palissya diffusa* of this work. The primary branches go off in a regularly pinnate manner like those of Walchia, but this is the only point of resemblance. The primary branches themselves branch, and the leaves are flat, and apparently in two rows; features that do not belong to Walchia. This plant has some resemblance to *Cheirolepis gracilis*, Feistmantel, *Araucarites gracilis*, Old. & Morr., from India. It may be a Cheirolepis and not a Palissya. Although the figure of Emmons's *Albertia latifolia* is very imperfect, it is clear that the plant is rather an Otozamites than an Albertia. The shape of the leaves and their insertion are similar to some Otozamites, while the nervation, as represented in the only complete leaflet on the plant, is given as forking near the margin of the leaflet. Even if the plant were a true Albertia, it could not, taken alone, be held as evidence of Triassic age. The more natural view would be to consider it as a survivor, remaining among the later plants. Indeed, when we consider that there is no evident unconformity between the lower and upper beds of the Mesozoic areas, while it is most probable that a portion, at least, of the lowest beds was deposited in Triassic times, it is surprising that we do not find quite a number of Triassic plants among those discovered in the Mesozoic of North Carolina and Virginia. *Pecopteris bullata* is the only remaining plant for which a Triassic age has been claimed. The very imperfect specimens of this fossil hitherto made known did not suffice to give its true character. It is clear that it has nothing in common with *Pecopteris* (or *Lepidopteris*) *Stuttgartensis*.*

The affinities of the North Carolina flora with Liassic plants are much closer than with those of the Trias. We have two species that are probably identical with Liassic plants, and six that are closely allied to those of the Liassic or lower Oölitic strata, giving 20 per cent. of Jurassic forms.

The affinities, however, point more strongly to a Rhætic age for this

*I omit in this table a reference to the relationship of *Asterocarpus platyrachis* with *A. Meriani*, and refer it for relationship to *Pecopteris concinna* Presl, of the Rhætic of Europe, as this is perhaps nearer.

flora than any other. We have 38 per cent. of the plants either identical with or very nearly allied to Rhætic fossils. Among these are many of the plants most highly characteristic of the Rhætic of Europe. Thus, we have among the North Carolina plants the genus *Palissya* represented by *P. Braunii* and *P. diffusa*, allied to *P. conferta* of the Lias of India. The genus *Palissya* is considered as highly characteristic of the Rhætic, and it is represented by still another species, *P. Carolinensis.* We have two Baieras, one, the common Rhætic form, *B. Münsteriana*, and the other *B. multifida*, having its nearest relation in *B. tæniata*, another Rhætic plant. *Macrotæniopteris gigantea* is a characteristic form of the Rhætic, and it is not clear that it is distinct from *M. magnifolia.* Besides these, we may enumerate such characteristic Rhætic plants as *Cheirolepis Münsteri*, *Sagenopteris rhoifolia*, *Asplenites Rösserti*, *Laccopteris elegans*, *Ctenophyllum Braunianum*, both varieties. The forms allied to Rhætic plants are hardly less significant..

The genus *Ctenophyllum* is highly characteristic of the Rhætic and Lias. This genus seems to contain the most abundant cycads in North Carolina. The genus *Acrostichides* is another which seems to be very characteristic of the Rhætic, and it is abundantly represented in North Carolina. We have *Acrostichides Egyptiacus* very near to *A. princeps; A. linnææfolius* near to *A. Gœppertianus;* and *A. rhombifolius* near to *Cyclopteris pachyrachis.* This type of Acrostichides, with its pinnules, showing a tendency to assume a rhomboid form for the sterile ones and a rounded form for the fertile ones, seems to be very characteristic of the Rhætic, for we can hardly doubt that *Cyclopteris* (or *Neuropteris*) *pachyrachis* is an Acrostichides. The genus *Laccopteris* is very characteristic of the Rhætic. It has, perhaps, three species in the North Carolina flora. One, *L. elegans*, seems to be identical with the European species; and two, *L. Emmonsi* and *L. Carolinensis*, are respectively near to *L. Münsteri* and *L. elegans.* I am, however, strongly inclined to think that *L. Carolinensis* is *L. elegans;* and, if this be the case, then we would have only two species of Laccopteris in this flora. The genus Cycadites is characteristic of the Rhætic, and more especially of the Jurassic. It is here present with two species. The genus *Podozamites* is eminently a Rhætic and Jurassic type. The *P. Emmonsi* is more nearly allied to Oölitic forms than to any others. It may be compared with *Podozamites lanceolatus minor*, Heer, "Flor. Foss. Arctica," vol. iv, plate xxvii, figs. 7 and 8.

European authors, and especially Schimper, often call attention to the strong resemblance between the Rhætic and Lower Jurassic floras, the likeness to the flora of the Lower Oölite of England being especially striking. In accordance with this fact, the presence of a marked Jurassic element in the flora of these Mesozoic beds, both in North Carolina and Virginia, is of itself an evidence that they cannot be older than Rhætic. We are, then, I think, entitled to consider that the older Mesozoic flora of North Carolina and Virginia is most probably Rhætic in age, and certainly not older.

Some authors hold that the Rhætic beds form the uppermost of the Triassic strata. Others think that they are transition beds, having more affinity with the Lower Lias. The latter view will, I think, be justified by a study of the flora, and I have, in this memoir, assumed its correctness.

EXPLANATIONS OF PLATES.

PLATE I.

FIG. 1. *Schizoneura planicostata.* (*Calamites planicostatus*, Rogers). Pages 14 to 16.
FIG. 2. Rhizome of *Equisetum Rogersi.* ? Page 11.
FIG. 3. Internal cast of Schizoneura, spec. ? Page 16.
FIGS. 4–6. *Schizoneura Virginiensis*, spec. nov. Page 17.
  FIG. 4. Portion of a stem showing several nodes.
  FIG. 5. Fragment of a smaller stem with broader leaves.
  FIG. 6. Leaf of full size of the broader kind.

PLATE II.

FIGS. 1, 1*a*, 2. *Equisetum Rogersi*, Schimper. Pages 10 to 13.
  FIG. 1. Impression of a large stem showing nodes.
  Fig. 1 *a*. Portion of the same magnified to show details.
  FIG. 2. Impression of a smaller stem on which the nodes are absent.
FIG. 3. A young plant, natural size, of *Macrotæniopteris magnifolia*, Rogers. Page 19.

PLATE III.

FIGS. 1–3. *Macrotæniopteris magnifolia* (Rogers) Schimper. Pages 18 to 22.
  FIG. 1. Leaf of the smaller kind, of natural size.
  FIG. 1*a*. Probable termination of leaf given in Fig. 1.
  FIG. 2. Young leaf of natural size.
  FIG. 3. Tip of leaf of medium size, showing a portion of the nervation.

PLATE IV.

FIGS. 1–4. *Macrotæniopteris magnifolia*, (Rogers) Schimper. Pages 18 to 22.
  FIG. 1. Leaf showing supposed fruit-dots on the stem, and at *a*, *b*, and *c*, the variations in the nervation.
  FIG. 1*a*. Portion of the stem of Fig. 1, magnified to show more distinctly the supposed fruit-dots.
  FIG. 2. Leaf of unusual shape, of natural size.
  FIGS. 3 and 4. Much reduced outlines, to show the two normal shapes of the entire leaves.

PLATE V (double).

FIGS. 1–4 *a*. *Macrotæniopteris magnifolia*, (Rogers) Schimper. Pages 18 to 22.
  FIGS. 1–3. Parts of the same leaf of *M. magnifolia*, of the largest size commonly attained.
    FIG. 1. Base of the leaf.
    FIG. 2. Middle portion of the same.
    FIG. 3. Summit of the same.
  FIG. 4. Nervation of the same magnified to show the compound nature of the lateral nerves.
  FIG. 4*a*. A lateral nerve of Fig. 4 still more magnified.
FIG. 5. *Macrotæniopteris crassinervis*, Feist. Pages 22 to 23. Fragment of a frond of the largest size.

PLATE VI.

FIGS. 1, 2. *Macrotæniopteris crassinervis*, Feist. Pages 22 to 23.

FIG. 1. A leaf of the smallest size.

FIG. 2. A leaf of the maximum size.

FIGS. 3, 3*a*. *Acrostichides linnææfolius* (Bunb. species). Pages 25 to 29.

FIG. 3. Represents a portion of a pinna from the lower part of a sterile frond.

FIG. 3*a*. Pinnule of the same magnified to show the nervation.

PLATE VII.

FIGS. 1–4. *Acrostichides linnææfolius* (Bunb. species). Pages 25 to 29.

FIG. 1. Ultimate pinnæ from the upper part of a large compound pinna, showing the pinnules all sterile.

FIG. 2. Ultimate pinnæ from the lower part of the same compound pinna from which Fig. 1 was taken, showing fertile and sterile pinnules on the same pinna.

FIG. 3. Tip of a fertile ultimate pinna.

FIG. 4. Portion of a fertile ultimate pinna, showing the transition in form from sterile to fertile pinnules.

FIG. 5. *Acrostichides microphyllus*, spec. nov. Pages 33 to 34.

FIG. 5. Shows a portion of the lower part of the frond.

PLATE VIII.

FIGS. 1, 1*a*. *Acrostichides linnææfolius* (Bunb. species). Pages 25 to 29.

FIG. 1. A portion of a sterile compound pinna from the upper part of a frond.

FIG. 1*a*. Pinnules of Fig. 1 magnified to show nervation.

FIGS. 2, 3*b*. *Acrostichides rhombifolius*, spec. nov. Pages 29 to 32.

FIG. 2. Terminal portion of a large ultimate pinna.

FIG. 2*a*. Pinnule of Fig. 2 magnified to show nervation.

FIG. 3. Portion of the upper part of a compound pinna when the ultimate pinnæ are passing into pinnules.

FIG. 3*a*. Magnified pinna from the lower part of Fig. 3.

FIG. 3*b*. Magnified pinna from the upper part of Fig. 3.

PLATE IX.

FIGS. 1, 1*a*. *Acrostichides linnææfolius* (Bunb. species). Pages 25 to 29.

FIG. 1. A fertile compound pinna.

FIG. 1*a*. Pinnules of the same magnified to show fructification and nervation.

PLATE X.

FIGS. 1, 1*a*, 1*b*, 1*c*. *Acrostichides densifolius*, spec. nov. Pages 34 to 35.

FIG. 1. Portion of the normal frond or compound pinna.

FIG. 1*a*. Magnified pinnules from the lower portion, and Fig. 1*b* magnified pinnules from the upper portion of Fig. 1, to show nervation.

FIG. 1*c*. Pinnules of Fig. 1 magnified to show the partial imbrication.

FIG. 2. *Acrostichides microphyllus*, spec. nov. Pages 33 to 34. Shows a very slender variety of this species.

PLATE XI.

FIGS. 1–3. *Acrostichides rhombifolius*, spec. nov. Pages 29 to 32.

FIG. 1. Portion of a compound sterile pinna showing pinnules of the largest size.

FIG. 1*a*. Pinnules of the same magnified to show nervation.

FIG. 2. Portion of the lower part of a compound sterile pinna to show the small size of the pinnules there.

FIG. 3. Fragment of a fertile ultimate pinna showing abnormal form of pinnules.

FIG. 4. *Acrostichides microphyllus*, spec. nov. Pages 33 to 34. Shows a very slender variety of this species that is not uncommon.

PLATE XII.

FIGS. 1, 2. *Acrostichides rhombifolius*, spec. nov. Pages 29 to 32.

FIG. 1. A common form of the sterile pinnules with prolonged tips.

FIG. 1*a*. Pinnules of Fig. 1 magnified to show nervation.

FIG. 2. Portion of the upper part of a compound sterile pinna, where the ultimate pinna are becoming simply lobed.

FIGS. 3, 3*a*. *Acrostichides microphyllus*, spec. nov. Pages 33 to 34.

FIG. 3. Gives the largest form seen of this species.

FIG. 3*a*. Pinnule of Fig. 3, magnified to show nervation.

PLATE XIII.

FIGS. 1, 2. *Acrostichides rhombifolius*, spec. nov. Pages 29 to 32.

FIG. 1. Represents the upper part of a compound sterile pinna where the pinnæ have become simple pinnules.

FIG. 1*a*. Pinnule of Fig. 1 magnified to show nervation.

FIG. 2. Upper portion of a compound fertile pinna where the ultimate pinnæ are simply lobed.

FIGS. 3, 3*a*, 3*b*. *Acrostichides rhombifolius*, var. *rarinervis*. Pages 32 to 33.

FIG. 3. Portion of a normal, sterile, compound pinna.

FIG. 3*a*. Pinnules from the lower part of Fig. 3.

FIG. 3*b*. Pinnules from the upper part of Fig. 3 magnified to show nervation.

PLATE XIV.

FIGS. 1, 2*a*. *Acrostichides rhombifolius*, spec. nov. Pages 29 to 32.

FIG. 1. Fragment of a large fertile compound pinna of common occurrence.

FIG. 1*a*. Pinnules of Fig. 1 magnified to show nervation and fructification.

FIG. 2. Fragment of a compound fertile pinna showing pinnules more rounded than those of Fig. 1; also common.

FIG. 2*a*. Pinnules of Fig. 2 magnified to show nervation and fructification.

PLATE XV.

FIGS. 1, 1*a*. *Mertensides distans*, spec. nov. Pages 39 to 40.

FIG. 1. Portion of a compound pinna of the normal kind.

FIG. 1*a*. Pinnules of Fig. 1 magnified to show the fructification.

FIGS. 2–5. *Mertensides bullatus* (Bunb. species). Pages 35 to 39.

FIG. 2. Portion of a compound fertile pinna of the most common kind, taken from the lower part of the pinna.

FIG. 3. Portion of an ultimate sterile pinna, taken from the lower part of the compound pinna.

FIG. 3*a*. Pinnule of Fig. 3 magnified to show nervation.

FIG. 4. Portion of a compound sterile pinna, showing large heteromorphous pinnules.

FIG. 5. Portion of a heteromorphous pinnule of the largest size.

PLATE XVI.

FIGS. 1–3. *Mertensides bullatus* (Bunb. species). Pages 35 to 39.

FIG. 1. Portion of a compound fertile pinna, showing the diminution in number of the sori towards the summit of the pinna.

FIG. 1 *a*. Pinnules of Fig. 1 magnified to show the fructification and nervation.

FIG. 2. Portion of the upper part of a compound sterile pinna showing uncommon form of the pinnules.

FIG. 2 *a*. Pinnules of Fig. 2 magnified to show nervation.

FIG. 3. Portion of a compound sterile pinna showing an unusual form for the pinnules.

PLATE XVII.

FIGS. 1–2 *a*. *Mertensides bullatus* (Bunb. species). Pages 35 to 39.

FIG. 1. Portion of the lower part of a compound sterile pinna.

FIG. 1 *a*. Pinnules of Fig. 1, magnified to show nervation.

FIG. 1 *b*. Heteromorphous pinnule of Fig. 1, magnified.

FIG. 2. Upper portion of a compound sterile pinna.

FIG. 2 *a*. Pinnules of Fig. 2, magnified to show nervation.

PLATE XVIII.

FIGS. 1, 2 *a*. *Mertensides bullatus*, (Bunb. species). Pages 35 to 39.

FIG. 1. Portion of the lower part of a compound fertile pinna, showing the pinnules with undulate margins, and the increase of sori towards the middle and summit portions of the ultimate pinnæ.

FIG. 2. Portion of a compound fertile pinna with fully fructified pinnules. A common form.

FIG. 2 *a*. Pinnules of Fig. 2, magnified to show the fructification.

PLATE XIX.

FIG. 1. *Mertensides bullatus* (Bunb. species). Pages 35 to 39. Portion of a fertile compound pinna, showing the sori and nervation as seen when the upper surface of the plant is presented to view.

FIGS. 2–5. *Asterocarpus Virginiensis*, spec. nov. Pages 41 to 45.

FIG. 2. Portion of the lower part of a compound sterile pinna, showing deeply lobed pinnules.

FIG. 2 *a*. Portion of Fig. 2, magnified to show nervation.

FIG. 3. Upper part of a sterile pinna, showing partially united pinnules.

FIG. 4. Portion of a sterile pinna, with pinnules having a very broad midrib.

FIG. 5. Summit of a sterile pinna.

PLATE XX.

FIGS. 1, 2. *Asterocarpus Virginiensis*, spec. nov. Pages 41 to 45.

FIG. 1. Three compound sterile pinnæ, that were once attached to a common rachis, showing the gradation in depth and shape of the lobes, from the lower to the upper and summit portions.

FIG. 1 *a*. Portion of the lower part of the lower compound pinna, magnified to show nervation.

FIG. 1 *b*. Portion of the summit of the uppermost compound pinna, magnified to show nervation.

FIG. 2. Summit of the middle compound pinna.

PLATE XXI.

FIGS. 1, 2. *Asterocarpus Virginiensis*, spec. nov. Pages 41 to 45.
FIG. 1. Several compound sterile pinnæ that were once attached to a common rachis, showing the diminishing depth of the lobes from base to summit.
FIG. 1*a*. Portion of a lower pinnule of Fig. 1, magnified to show the nervation.
FIG. 1*b*. Pinnule from the upper part of Fig. 1, magnified to show nervation.
FIG. 2. Portion of a sterile pinna with large, broad pinnules.
FIGS. 3, 4. *Asterocarpus Virginiensis*, var. *obtusilobus*. Page 45 to 46.
FIG. 3. Summit of a sterile ultimate pinna magnified.
FIG. 4. Upper part of a compound sterile pinna.

PLATE XXII.

FIGS. 1–3. *Asterocarpus Virginiensis*, spec. nov. Pages 41 to 45.
FIG. 1. Portion of a sterile compound pinna with large pinnules. A common form.
FIG. 1*a*. Pinnule of Fig. 1, magnified to show nervation.
FIG. 2. Portion of a compound pinna showing fructification only at the tips of the pinnules.
FIG. 3. Portion of the stipe.

PLATE XXIII.

FIGS. 1–4*a*. *Asterocarpus Virginiensis*, spec. nov. Pages 41 to 45.
FIG. 1. Several fertile pinnæ that were once attached to a common rachis, seen from the upper surface with the sori showing through the leaf substance of the pinnules.
FIG. 2. Portion of the lower part of a compound fertile pinna, seen as in Fig. 1.
FIG. 3. Portion of a compound sterile pinna showing unusually large pinnules with undulate margins.
FIG. 4. Portion of a fertile pinna seen from the under side and showing the true form of the sori.
FIG. 4*a*. Portion of the pinnule of Fig. 4, magnified to show the form of the sori.

PLATE XXIV.

FIGS. 1, 2*a*. *Asterocarpus Virginiensis* ? spec. nov. Page 42.
FIG. 1. Portion of a compound fertile pinna of perhaps a variety of *A. Virqiniensis*.
FIG. 2. Fragment of a larger form of the same plant.
FIG. 2*a*. Pinnules of Fig. 2, magnified to show the sori.
FIGS. 3–5*a*. *Asterocarpus Virginiensis*, var. *obtusilobus*. Pages 45 to 46.
FIG. 3. Portion of a sterile compound pinna of the normal form.
FIG. 3*a*. Pinnules of Fig. 3, magnified to show the nervation.
FIG. 4. Portion of a long sterile ultimate pinna.
FIG. 4*a*. Pinnule of Fig. 4 magnified.
FIG. 5. Ultimate sterile pinna with broad deep lobes.
FIG. 5*a*. Pinnule of Fig. 5 magnified.

PLATE XXV.

FIGS. 1, 1*a*. *Asterocarpus Virginiensis*, var. *obtusilobus*. Pages 45 to 46.
FIG. 1. Shows a form with broad rounded lobes and a fine, closely crowded nervation.
FIG. 1*a*. Pinnules of Fig. 1, magnified to show the nervation.
FIGS. 2–6. *Asterocarpus platyrachis*, spec. nov. Pages 46 to 47.
FIG. 2. Upper part of a compound sterile pinna.
FIG. 3. Portion of a fertile compound pinna with fully fructified pinnules.
FIG. 3*a*. Pinnules of Fig. 3, magnified to show the sori.

FIGS. 3*b* and 3*c*. Single sori of somewhat different form, much magnified.
FIG. 4. A portion of the lower part of a compound sterile pinna.
FIG. 4*a*. Pinnules of Fig. 4, magnified to show the nervation.
FIG. 5. Fragment of pinna showing fertile and sterile pinnules on the same pinna.
FIG. 6. Summit of a sterile compound pinna.

PLATE XXVI.

FIG. 1. *Asterocarpus platyrachis*, spec. nov. Pages 46 to 47. Upper part of a fertile compound pinna.
FIGS. 2, 2*a*. *Asterocarpus penticarpus*, spec. nov. Page 48.
FIG. 2. Portion of a fertile frond.
FIG. 2*a*. Pinnules of Fig. 2, magnified to show the sori.
FIGS. 3–4*a*. *Pecopteris rarinervis*, spec. nov. Pages 48 to 49.
FIG. 3. Portion of an ultimate pinna.
FIG. 3*a*. Pinnule of Fig. 3, magnified to show nervation.
FIG. 4. Summit of an ultimate pinna.
FIG. 4*a*. Pinnules of Fig. 4, magnified to show nervation.
FIGS. 5, 5*a*. *Cladophlebis ovata*, spec. nov. Pages 50 to 51.
FIG. 5. Normal form of the plant.
FIG. 5*a*. Pinnules of Fig. 5, magnified to show nervation.
FIGS. 6–7. *Cladophlebis auriculata*, spec. nov. Page 50.
FIG. 6. Normal form of the plant.
FIG. 6*a*. Pinnule of Fig. 6, magnified to show nervation.
FIG. 7. Abnormal form of the pinnules.

PLATE XXVII.

FIGS. 1, 1*a*. *Cladophlebis rotundiloba*, spec. nov. Pages 52 to 53.
FIG. 1. Portion of pinna.
FIG. 1*a*. Pinnules of Fig. 1, magnified to show nervation.
FIGS. 2, 2*a*. *Cladophlebis microphylla*, spec. nov. Pages 51 to 52.
FIG. 2. Portion of the upper part of a compound pinna, or of the frond.
FIG. 2*a*. Pinnules of Fig. 2, magnified to show nervation.
FIG. 3. *Cladophlebis ovata*, spec. nov. Pages 50 to 51. Gives a portion of the lower part of a compound pinna, or of the frond.
FIGS. 4, 4*a*. *Cladophlebis pseudowhitbiensis*, spec. nov. Page 52.
FIG. 4. Portion of a compound pinna, or of the frond.
FIG. 4*a*. Pinnule of Fig. 4, magnified to show nervation.

PLATE XXVIII.

FIGS. 1–2. *Lonchopteris Virginiensis*, spec. nov. Pages 53 to 54.
FIG. 1. Summit of a large compound pinna, or of the frond.
FIG. 1*a*. Pinnules of Fig. 1, magnified to show nervation.
FIG. 2. Portion of a pinna with long acute pinnules.

PLATE XXIX.

FIGS. 1–4. *Lonchopteris Virginiensis*, spec. nov. Pages 53 to 54.
FIG. 1. Portion of frond with normal, rounded pinnules.
FIG. 1*a*. Pinnule of Fig. 1, magnified to show nervation.
FIG. 2. Portions of pinnæ, with normal acute pinnules.

FIG. 3. Portion of a pinna with pinnules of the largest size.
FIG. 4. Portions of pinnæ showing broad rounded pinnules.
FIGS. 5, 5*a*. *Cladophlebis subfalcata*, spec. nov. Page 49.
FIG. 5. Shows the normal character.
FIG. 5*a*. Pinnule of Fig. 5, magnified to show nervation.

PLATE XXX.

FIGS. 1–4*a*. *Pseudodanæopsis reticulata*, spec. nov. Pages 59 to 60.
FIG. 1. Portion of the frond restored, showing pinnules of large size.
FIG. 2. Fragment of a very large pinnule.
FIG. 2*a*. Portion of Fig. 2, magnified to show nervation.
FIG. 3. Portion of a frond with pinnules of the smaller kind.
FIG. 4. Upper part of a compound pinna with small pinnules.
FIG. 4*a*. Portion of a pinnule of Fig 4, much magnified to show nervation.
FIG. 5. *Sagenopteris rhoifolia*, Pr. Page 63. Fragment of a leaflet.
FIG. 6. *Dicranopteris*, Spec. (?). Page 63. Gives a fragment of a leaf like Dicranopteris.

PLATE XXXI.

FIGS. 1, 2. *Pseudodanæopsis nervosa*, spec. nov. Pages 61 to 63.
FIG. 1. Portion of the plant showing pinnules of normal size.
FIG. 2. Portion of the upper part of the plant.
FIGS. 3, 4. *Clathropteris platyphylla*, var. *expansa*, Sap. Pages 54 to 58.
FIG. 3. Portion of a small segment showing only the cross-bars of the nervation.
FIG. 4. Portion of a segment of normal size showing three teeth on the right-hand border and one on the left-hand border.

PLATE XXXII.

FIG. 1. *Clathropteris platyphylla*, var. *expansa*, Sap. Pages 54 to 58. Represents a segment with incomplete margins, but quite long.
FIGS. 2–4. *Pterophyllum affine*, Nathorst. Pages 66 to 67.
FIG. 2. Fragment with the broadest leaflets.
FIG. 3. Fragment of leaf with average-sized leaflets.
FIG. 4. Fragment with leaflets of the narrowest kind.

PLATE XXXIII.

FIG. 1. *Clathropteris platyphylla*, var. *expansa*, Sap. Pages 54 to 58. Shows the basal undivided part of the frond.
FIG. 2. *Podozamites Emmonsi* (*P. lanceolatus* of Emmons). Pages 77 to 78. Gives a form with leaflets rather narrower than the normal form given by Emmons.
FIGS. 3–4*a*. *Ctenophyllum taxinum* (Lind. and Hut.). Pages 67 to 68.
FIG. 3. Lower portion of a leaf.
FIG. 4. Upper portion of a leaf.
FIG. 4*a*. Leaflet of Fig. 4, magnified to show nervation.

PLATE XXXIV.

FIG. 1. *Clathropteris platyphylla*, var. *expansa*, Sap. Pages 54 to 58. Portion of the undivided part of a large frond.

FIGS. 2–4*a*. *Ctenophyllum Braunianum*, Goepp. Pages 69 to 73.

FIG. 2. Fragment of the lowest part of a leaf next to the leafless petiole.

FIG. 3. Fragment from the upper part of a leaf.

FIG. 4. Fragment from the middle part of a leaf.

FIG. 4*a*. Portion of Fig. 4, magnified to show nervation.

PLATE XXXV.

FIG. 1. *Ctenophyllum Braunianum*, Goepp. Pages 69 to 73. Fragment of the upper part of a large leaf.

FIGS. 2, 2*a*. *Clathropteris platyphylla*, var. *expansa*, Sap. Pages 54 to 58.

FIG. 2. Fragment of a very large segment.

FIG. 2*a*. Portion of Fig. 2, magnified to show nervation.

PLATE XXXVI.

FIGS. 1, 1*a*, 1*b*, 1*c*. *Pterophyllum inæquale*, spec. nov. Pages 64 to 65.

FIG. 1. Leaf of normal kind.

FIG. 1*a*. Summit of Fig. 1.

FIG. 1*b*. Portion of a leaflet from the lower part of Fig. 1, magnified to show nervation.

FIG. 1*c*. Portion of a leaflet from Fig. 1*a*, magnified to show nervation.

PLATE XXXVII.

FIGS. 1–2. *Ctenophyllum Braunianum*, Goepp. Pages 69 to 73.

FIG. 1. Upper portion of a large leaf.

FIG. 1*a*. Portion of the petiole of Fig. 1.

FIG. 2. Fragment of a middle portion of a leaf, showing leaflets unusually distant.

PLATE XXXVIII.

FIGS. 1–2*a*. *Ctenophyllum Braunianum*, Goepp. Pages 69 to 73.

FIG. 1. Summit of the large leaf given in Fig. 1, Plate XXXVII.

FIG. 2. Upper portion of a leaf, showing the rounded form of the midrib on the under side.

FIG. 2*a*. Base and summit of a leaflet of Fig. 2, magnified to show nervation.

FIGS. 3–5. *Ctenophyllum truncatum*, spec. nov. Pages 68 to 69.

FIG. 3. Upper portion of a leaf.

FIG. 4. Portion of a leaf, with the leaflets all broken at base.

FIG. 5. Shows natural position of leaflets in Fig. 4.

PLATE XXXIX.

FIGS. 1–3*a*. *Ctenophyllum grandifolium*, spec. nov. Pages 73 to 76.

FIG. 1. Fragment of the lower part of the leaf, showing the great width of the flat stem.

FIG. 1*a*. Portion of Fig. 1, magnified to show the insertion of the nerves.

FIG. 2. Portion of the middle of a leaf with remote leaflets; also showing the thick epidermis of the stem and the effect of it in increasing the apparent width of the stem.

FIG. 3. Fragment of the upper part of a leaf.

FIG. 3*a*. Portion of a leaflet of Fig, 3, magnified to show nervation.

FIG. 5. *Ctenophyllum giganteum*, spec. nov. Pages 76 to 77. Shows a portion of a leaflet of a huge Ctenophyllum. The basal portion of the leaflet is that given here.

PLATE XL.

Ctenophyllum grandifolium, spec. nov. Pages 73 to 76. Represents the basal portion of a very large leaf of this plant. The leaflets extend to 12 and 18 inches in width.

PLATE XLI (double).

FIGS. 1, 2. *Ctenophyllum grandifolium*, spec. nov. Pages 73 to 76.
FIG. 1. Represents the middle portion of the same leaf whose base was given on Plate XL.
FIG. 2. Lower portion of the plant given on Plate XL

PLATE XLII (double).

FIG. 1, 1 *a*, 1 *b*. *Ctenophyllum grandifolium*, spec. nov. Pages 73 to 76.
FIG. 1. Represents the summit of the same large leaf whose base is given on Plate XL, and middle portion in Fig. 1, Plate XLI.
FIG. 1 *a*. Represents the middle portion of a leaflet of Fig. 1, magnified to show the parallel position of the nerve-bundles.
FIG. 1 *b*. Represents a portion of the base of a leaflet of Fig. 1, still more magnified, to show the complex nature and mode of splitting up of the nerve-bundles at their base.
FIGS. 2–5. *Podozamites tenuistriatus*, spec. nov. Pages 78 to 79.
FIG. 2. Gives a fragment of a leaf of the largest form.
FIG. 3. Gives a portion of a leaf of normal size.
FIG. 3 *a*. Leaflet of Fig. 3, magnified to show nervation.
FIG. 3 *b*. Tip of Fig. 3 *a*, still more magnified to show convergence of the nerves at their ends.
FIG. 4. Fragment of a plant showing insertions of leaflets perhaps flattened from above.
FIG. 5. Leaflet of largest size.

PLATE XLIII.

FIG. 1, 1 *a*. *Sphenozamites Rogersianus*, spec. nov. Pages 80 to 84.
FIG. 1. Summit of a leaf of medium size.
FIG. 1 *a*. Belongs to the lowest leaflet on the right-hand side.
FIG. 2. *Pterophyllum decussatum*, Emmons. Page 67.
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PLATE XLIV.

FIGS. 1–2 *b*. *Sphenozamites Rogersianus*, spec. nov. Pages 80 to 84.
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FIG. 3. *Podozamites tenuistriatus*, spec. nov. Pages 78 to 79. Shows a form with leaflets broad near the insertions.
FIGS. 4–6. *Cycadites tenuinervis*, spec. nov. Page 84.
FIG. 4. Represents the upper part of a leaf.
FIG. 5. Represents the middle part of a leaf.
FIG. 6. Represents a small form.

PLATE XLV (double).

FIGS. 1, 2. *Sphenozamites Rogersianus*, spec. nov. Pages 80 to 84.
FIG. 1. Represents the summit of a leaf of normal size.
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FIG. 3. *Baiera multifida*, spec. nov. Pages 87 to 88. Basal portion of a leaf.

PLATE XLVI.

FIGS. 1–3. *Baiera multifida*, spec nov. Pages 87 to 88.
FIG. 1. Portion of a leaf showing the numerous subdivisions towards the summit of the leaf.
FIG. 2. Portion of the lower part of a leaf showing nervation.
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PLATE XLVII.

FIGS. 1, 2. *Baiera multifida*, spec. nov. Pages 87 to 88.
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PLATE XLVIII.

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PLATE XLIX.

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PLATE LI.

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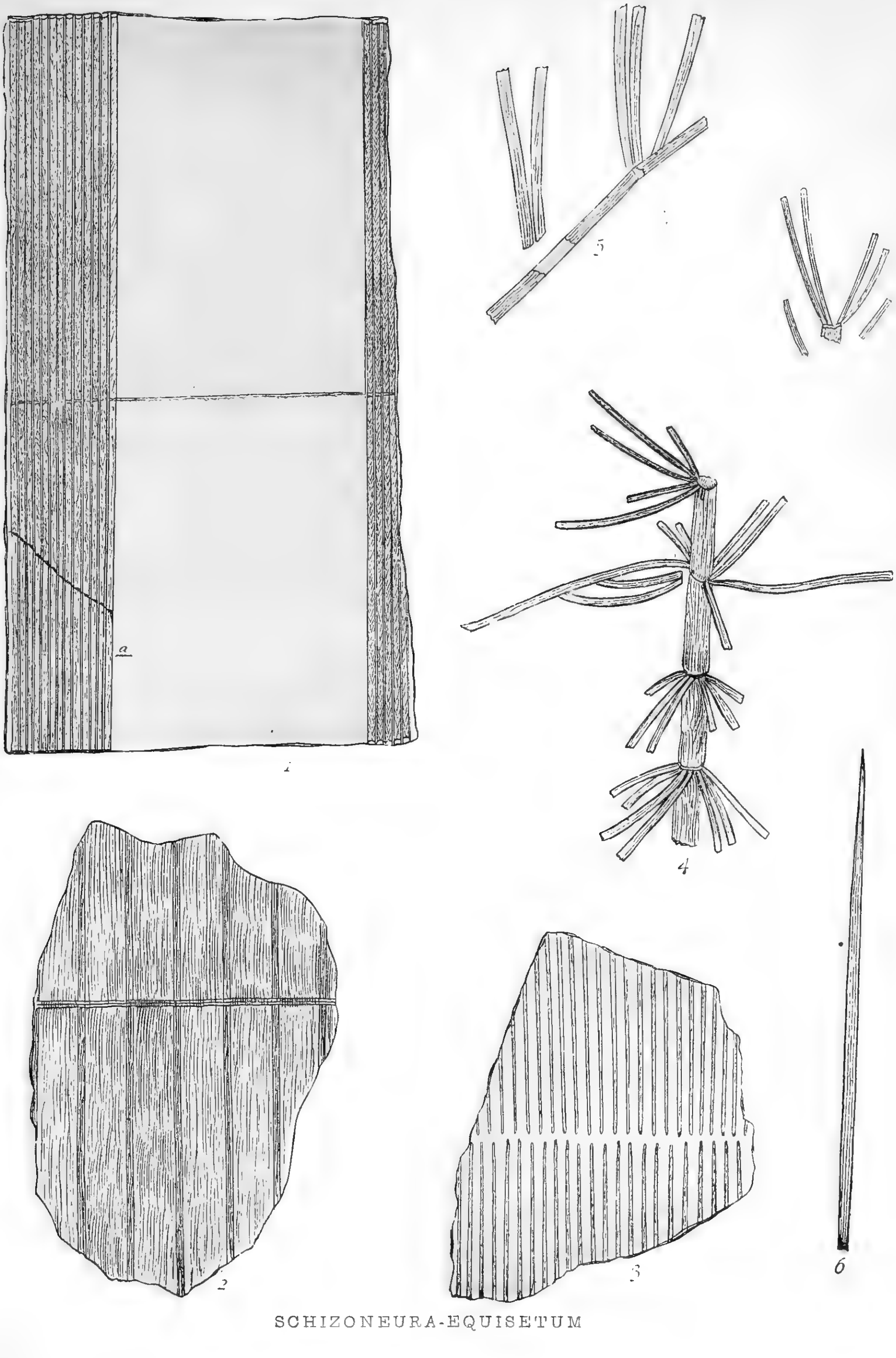
P. rarinervis, spec. nov. Pp. *48 to 49; 94. Plate XXVI, Figs. 3, 4.
P. Stuttgartensis Brongt. Pp. 125, 126.
P. truncata, Germar. Page 47.
P. Whitbiensis, Brongt. Pp. 27, 28, 52, 94.
P. Williamsoni, Brongt. Page 24.
Phœnicopsis, Heer. Page 90.
Pinus strobus. Page 87.
Pittsylvania Area of Older Mesozoic. Pp. 4, 5, 6.
Podozamites, Fr. Braun. emend. Pp. 77, 95, 111.
P. angustifolius, Schenk. Pp. 78, 95.
P. Emmonsi (Em. spec.). Pp. *77 to 78; 79, 95, 110, 127. Plate XXXIII, Fig. 2.
P. lanceolatus, Emmons. Pp. 77, 78, *110. Plate LIII, Fig. 2. Emmons, "Am. Geol.," page 116, plate 3, fig. 7.
P. lanceolatus, Schimp. Page 78.
P. lanceolatus minor, Heer. Page 128.
P. longifolius, Emmons. Page *111. Plate LIII, Fig. 5. Emmons, "Am. Geol.," page 116, fig. 83.
P. tenuistriatus (Rogers' spec.) Pp. *78 to 79; 85, 95. Plate XLII, Figs. 2 to 5.
Pseudodanæopsis, gen. nov. Pp. 58 to 59; 95, 96.
P. nervosa, spec. nov. Pp. *61 to 62; 115. Plate XXII, Figs. 1, 2.
P. reticulata, spec. nov. Pp. *59 to 60; 62, 116. Plate XXX, Figs. 1 to 4.
Pterophyllum, Brongt. Page 63.
P. æquale, Nat. Pp. 65, 111.
P. affine, Nat. Page *66. Plate XXII, Figs. 2 to 4.
P. Andræanum, Schimp. Pp. 67, 114, 125.
P. Blasii, Schimp. Page 104.
P. Bronnii, Schenk. Page 74.
P. Carterianum, Old. Page 74.
P. decussatum (Em. Spec.). Pp. *67, *111, 125. Plate XLIII, Fig. 2; Plate LI, Fig. 2.
P. delicatulum, Newb. Page 66.
P. distans, Mor. Page 74.
P. Footeanum, Feist. Pp. 74, 95.
P. giganteum, Schenk. Page 74.
P. Humboldtianum, Dunk. Page 111.
P. imbricatum, Ett. Page 68.
P. inæquale, spec. nov. Pp. *64 to 65; 114. Plate XXXVI, Fig. 1.
P. Jægeri. Page 111.
P. Kingianum, Feist. Page 74.
P. longifolium, Brongt. Pp. 64, 65, 67, 125.
P. longifolium, Andræ. Pp. 65, 67, 114.
P. Lyellianum, Dunk. Page 112.
P. Meriani, Heer. Page 68.
P. Morrisianum, Old. Page 74.
P. pectinatum (Em. spec.). Page *112. Plate LIII, Fig. 4.
P. Preslanum, Bronn. Page 73.
P. princeps, Old. & Mor. Page 66.
P. propinquum, Schenk. Page 66.
P. Rajmahalense, Mor. Page 66.
P. robustum, Emmons. Pp. 74, 113, *116. Plate LIV, Figs. 5, 6, 7.
P. spatulatum (Em. spec.). Page *114. Plate LIII, Fig. 6.
Pterozamites Blasii, Schimp. Page 104.
P. decussatus, Emmons. Pp. 65, *67, 90, *111, 125. Plate XLIII, Fig. 2; Plate LI, Fig. 2. Emmons, "Am. Geol.," page 117; plate 3, fig. 1.
P. gracilis, Emmons. Pp. 73, *113. Plate LIV, Fig. 5. Emmons, "Am. Geol.," p. 118, fig. 86.
P. linearis, Emmons. Page *114. Plate LIV, Fig. 2. Emmons, "Am. Geol.," p. 120, fig. 87.
P. obtusifolius, Emmons. Page *112. Plate LIV, Fig. 4. Emmons, "Am. Geol.," page 118, fig. 85.
P. obtusus, Emmons. Pp. 73, *113. Plate LIV, Fig. 1. Emmons, "Am. Geol., page 119, fig. 86a.
P. pectinatus, Emmons. Page *112. Plate LIII, Fig. 4. Emmons, "Am. Geol.," p. 117, fig. 84.
P. Spatulatus, Emmons. Pp. 69, *114. Plate LIII, Fig. 6. Emmons, "Am. Geol.," page 120, fig. 88.
Rajmahal Group, Age of. Page 123.
Rajmahal Group, Flora of. Page 96.
Richmond Area of Older Mesozoic. Pp. 2, 3, 4, 6.
Richmond Coal Field. Pp. 3, 7, 8, 9.
Sagenopteris Mantelli, Schenk. Page 110.
S. rhoifolia, Presl. Pp. *63, 104. Plate XXX, Fig. 5.
S. rhoifolia (Em. spec.) Presl. Page *104. Plate XLIX, Fig. 5.
Salisburia, Sm. Pp. 85, 86.
Saportea, F. & W. Page 86.
Schizoneura, Schimp. Page 16.
S. hœrensis, Schimp. Pp. 17, 95.
S. lateralis (L. & H.), Schimp. Page 17.
S meriani, Heer. Page 17.
S. planicostata (Rogers spec.). Page *14. Plate I, Fig. 1.
S. species? Pp. *16, 95. Plate I, Fig. 3.

S. Virginiensis, spec. nov. Pp. *17, 93, 95. Plate I, Figs. 4 to 6.
Sphenoglossum quadrifoliatum, Emmons. Page *120. Plate LII, Fig. 3. Emmons, "Am. Geol.," page 134; plate 5, fig. 2.
Sphenolepis Kurriana, Schenk. Page 110.
S. Sternbergiana, Schenk. Page 110.
Sphenopteris Egyptiaca, Emmons. Pp. 98, *99. Plate XLVIII, Fig. 8. Emmons, "Am. Geol.," page 36, fig. 8.
S. obtusiloba, Andræ. Page 106.
S. Rössertiana, Presl. Pp. 94, 106.
Sphenozamites, Brongt. Pp. 79, 80, 95.
S. latifolius, Sap. Page 83.
S. Rogersianus, spec. nov. Pp. *80 to 84; 95. Plate XLIII, Fig. 1; Plate XLIV, Figs. 1, 2; Plate XLV, Figs. 1, 2.
S. Rogersianus (Em. spec.). Page *98. Plate XLIX, Fig. 4.
S. Rossii, Zigno. Page 83.
Steierdorf, Flora of. Page 96.
Strangerites obliquus, Emmons. Pp. 62, *115. Plate LIV, Fig. 8. Emmons, "Am. Geol.," page 121, fig. 89.
S. planus, Emmons. Pp. 60, *116. Plate LIV, Fig. 3. Emmons, "Am. Geol.," page 122, fig. 90.
Table of the Older Mesozoic Plants of North Carolina. Pp. 122 to 123.
Table of the Older Mesozoic Plants of Virginia. Pp. 92 to 93.
Tæniopteris glossopteroides, Newb. Page 62.
T. lata, Old. & Mor. Page 22.
T. magnifolia, Rogers. Page 103.
Theta, Flora of, Page 96.
Trias of North Carolina. Page 100.
Undetermined Cones. Page *91, Plate XLVII, Fig. 3; Plate XLVIII, Fig. 1.
Undetermined Fern, Emmons. Page *105. Plate LIV, Fig. 9.
Undetermined Fern, Emmons. Page *105. Plate LI, Fig. 6.
Undetermined Plant, Emmons. Page *119. Plate LII, Fig. 2. Emmons, "Am. Geol.," page 131, fig. 99.
Undetermined Stem. Page *91. Plate XLVIII, Fig. 5.
Walchia angustifolia, Emmons. Pp. 98, *99. Plate XLIX, Fig. 10. Emmons, "Am. Geol.," page 35, plate 3, fig. 3.
W. brevifolia, Emmons. Pp. 89, *107, 110. Plate LIII, Fig. 3. Emmons, "Am. Geol.," page 107, fig. 74.
W. diffusus, Emmons. Pp. *106, 126. Plate LI, Fig. 4. Emmons, "Am. Geol.," page 105, pl. 3, fig. 3.
W. gracile, Emmons. Pp. 89, *108, 110. Plate L, Fig. 3. Emmons, "Am. Geol.," page 108, fig. 75.
W. longifolius, Emmons. Page *107. Plate L, Figs. 1, 2; Plate LI, Fig. 1. Emmons, "Am. Geol.," pp. 105, 106, figs. 72, 73, and pl, 4 *a*.
W. variabilis, Emmons. Pp. 89, *108. Plate L, Fig. 4. Emmons, "Am. Geol.," p. 108, fig. 76.
Zamia gigas, Lindl. & Hut. Page 91.
Z. pecten, Lindl. & Hut. Pp. 68, 73.
Z. taxina, Lindl. & Hut. Page 68.
Zamites distans, Presl. Page 77.
Z. Dunkerianus, Andræ. Page 72.
Z. gracilis, Andræ. Page 68.
Z. gramineus, Bunb. Page 115.
Z. lanceolatus, Lindl. & Hut. Pp. 77, 78.
Z. obtusifolius, Rogers. Pp. 72, 115.
Z. proximus, Feist. Page 111.
Z. tenuistriatus, Rogers. Page 78.
Zamiostrobus Emmonsi (Em. spec.). Page *117. Plate LII, Fig. 5. Emmons, Am. Geol.," p. 123, fig. 92 *a*.
Z. Virginiensis, spec. nov. Page *85. Plate XLVII, Figs. 4, 5.

PLATE I.

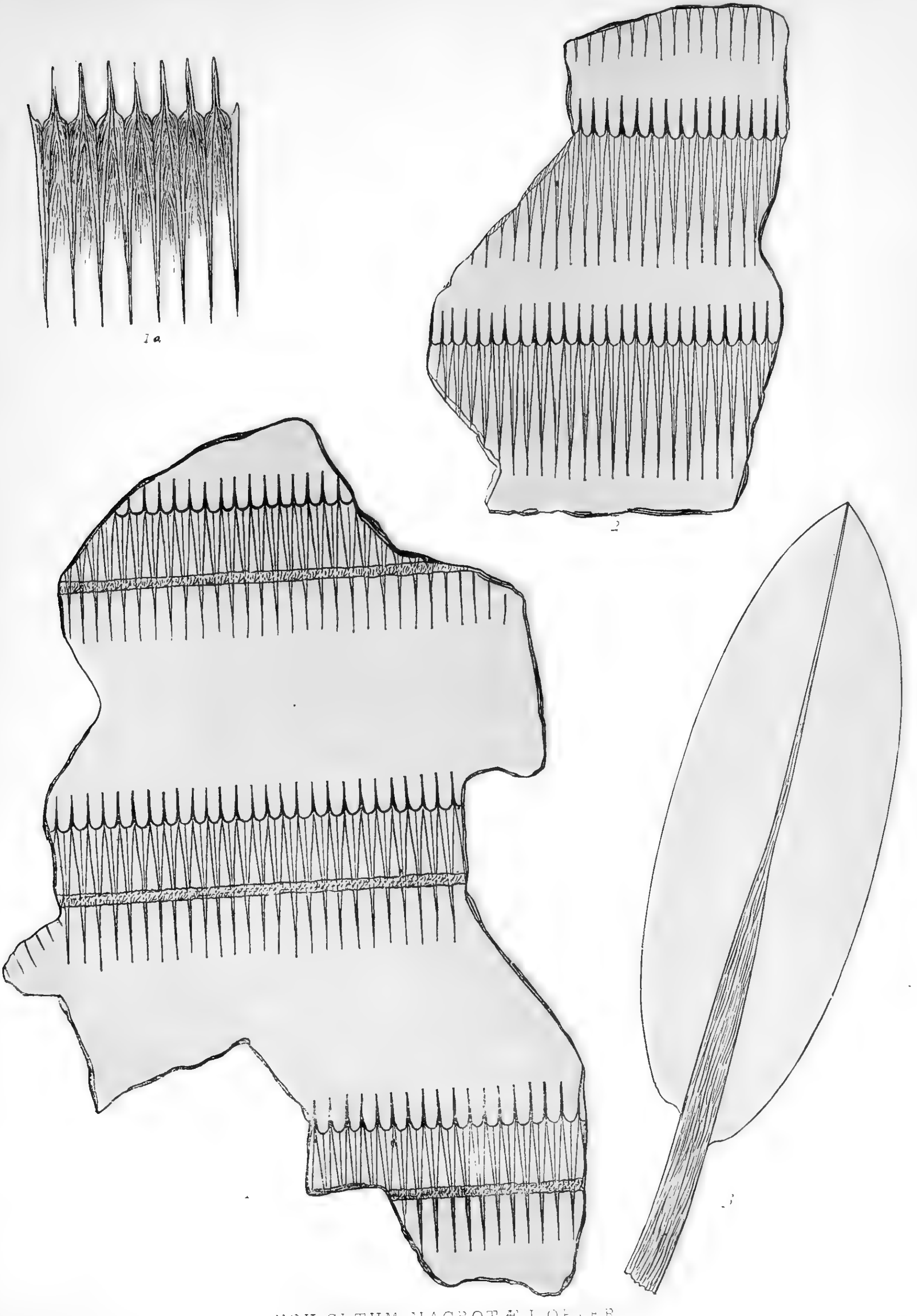
FIG. 1. *Schizoneura planicostata.* (*Calamites planicostatus*, Rogers). **Pages 14 to 16.**
FIG. 2. Rhizome of *Equisetum Rogersi.* ? Page 11.
FIG. 3. Internal cast of Schizoneura, spec. ? Page 16.
FIGS. 4–6. *Schizoneura Virginiensis*, spec. nov. Page 17.
  FIG. 4. Portion of a stem showing several nodes.
  FIG. 5. Fragment of a smaller stem with broader leaves
  FIG. 6. Leaf of full size of the broader kind.



SCHIZONEURA-EQUISETUM

PLATE II.

FIGS. 1, 1*a*, 2. *Equisetum Rogersi*, Schimper. Pages 10 to 13.
FIG. 1. Impression of a large stem showing nodes.
Fig. 1*a*. Portion of the same magnified to show details.
FIG. 2. Impression of a smaller stem on which the nodes are absent.
FIG. 3. A young plant, natural size, of *Macrotæniopteris magnifolia*, Rogers. **Page 19.**



EQU SETUM-MACROTÆLI OF EF..

PLATE III.

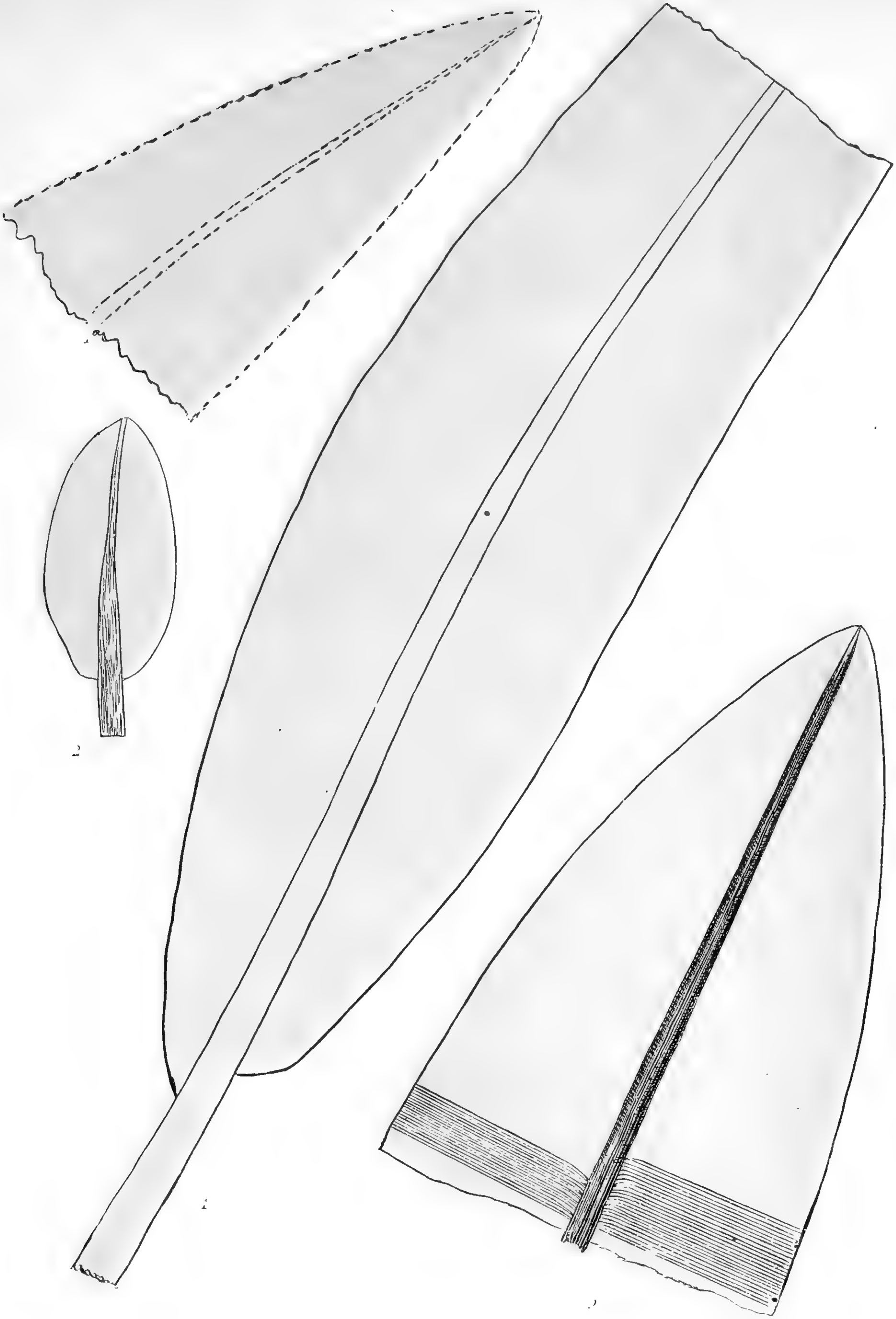
FIGS. 1–3. *Macrotæniopteris magnifolia*, Rogers (Schimper). Pages 18 to 22.

FIG. 1. Leaf of the smaller kind, of natural size.

FIG. 1*a*. Probable termination of leaf given in Fig. 1.

FIG. 2. Young leaf of natural size.

FIG. 3. Tip of leaf of medium size, showing a portion of the nervation.



MACROTÆNIOPTERIS MAGNIFOLIA

PLATE IV.

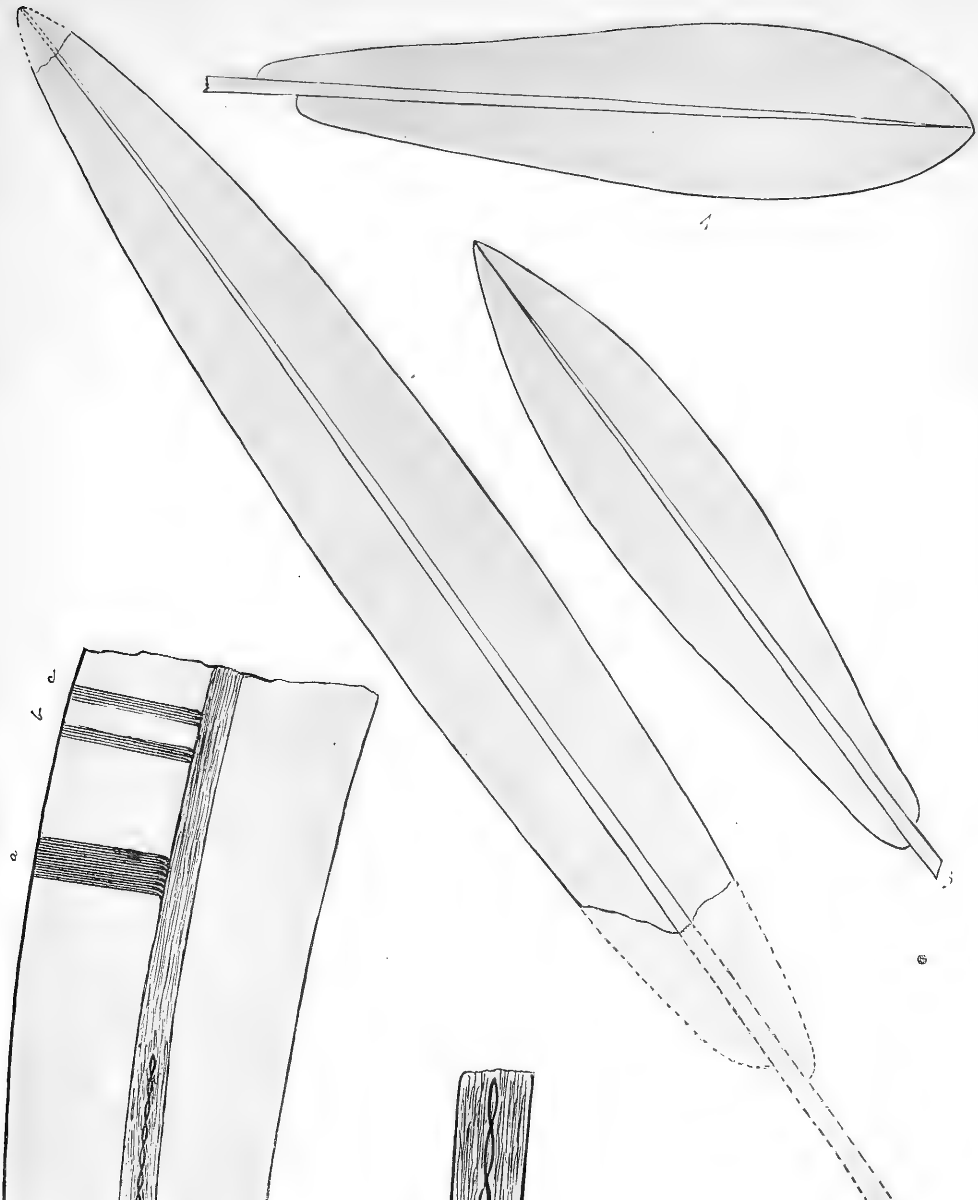
FIGS. 1–4. *Macrotæniopteris magnifolia,* (Rogers) Schimper. Pages 18 to 22.

FIG. 1. Leaf showing supposed fruit-dots on the stem, and at *a*, *b*, and *c*, the variations in the nervation.

FIG. 1*a*. Portion of the stem of Fig. 1, magnified to show more distinctly the supposed fruit-dots.

FIG. 2. Leaf of unusual shape, of natural size.

FIGS. 3 and 4. Much reduced outlines, to show the two normal shapes of the entire leaves.



MACROTÆNIOPTERIS MAGNIFOLIA

PLATE V (double).

FIGS. 1–4 *a*. *Macrotæniopteris magnifolia,* (Rogers) Schimper. Pages 18 to 22.

FIGS. 1–3. Parts of the same leaf of *M. magnifolia,* of the largest size commonly attained.

FIG. 1. Base of the leaf.

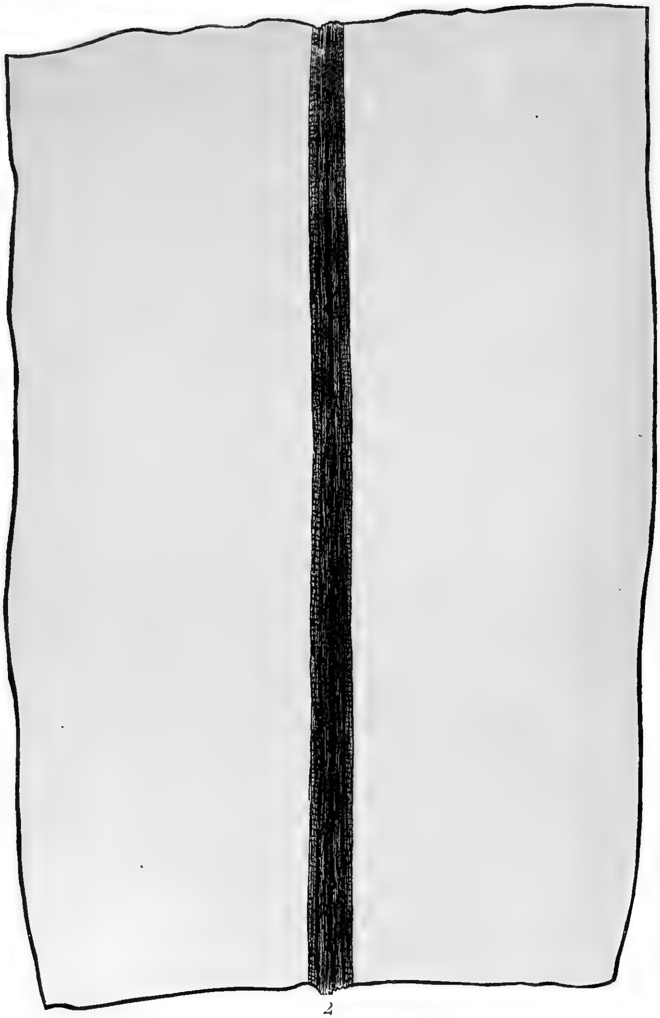
FIG. 2. Middle portion of the same.

FIG. 3. Summit of the same.

FIG. 4. Nervation of the same magnified to show the compound nature of the lateral nerves.

FIG. 4 *a*. A lateral nerve of Fig. 4 still more magnified.

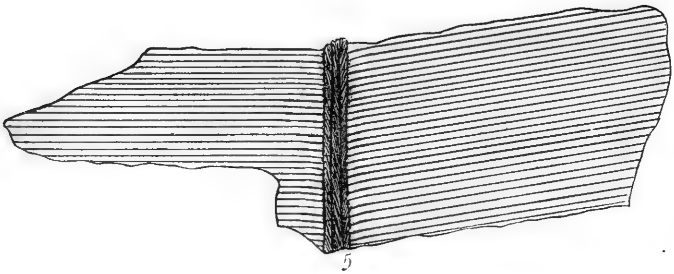
FIG. 5. *Macrotæniopteris crassinervis,* Feist. Pages 22 to 23. Fragment of the frond of the largest size.



2

4 a

3



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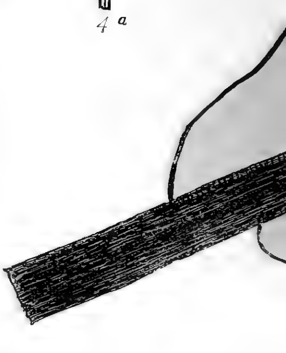
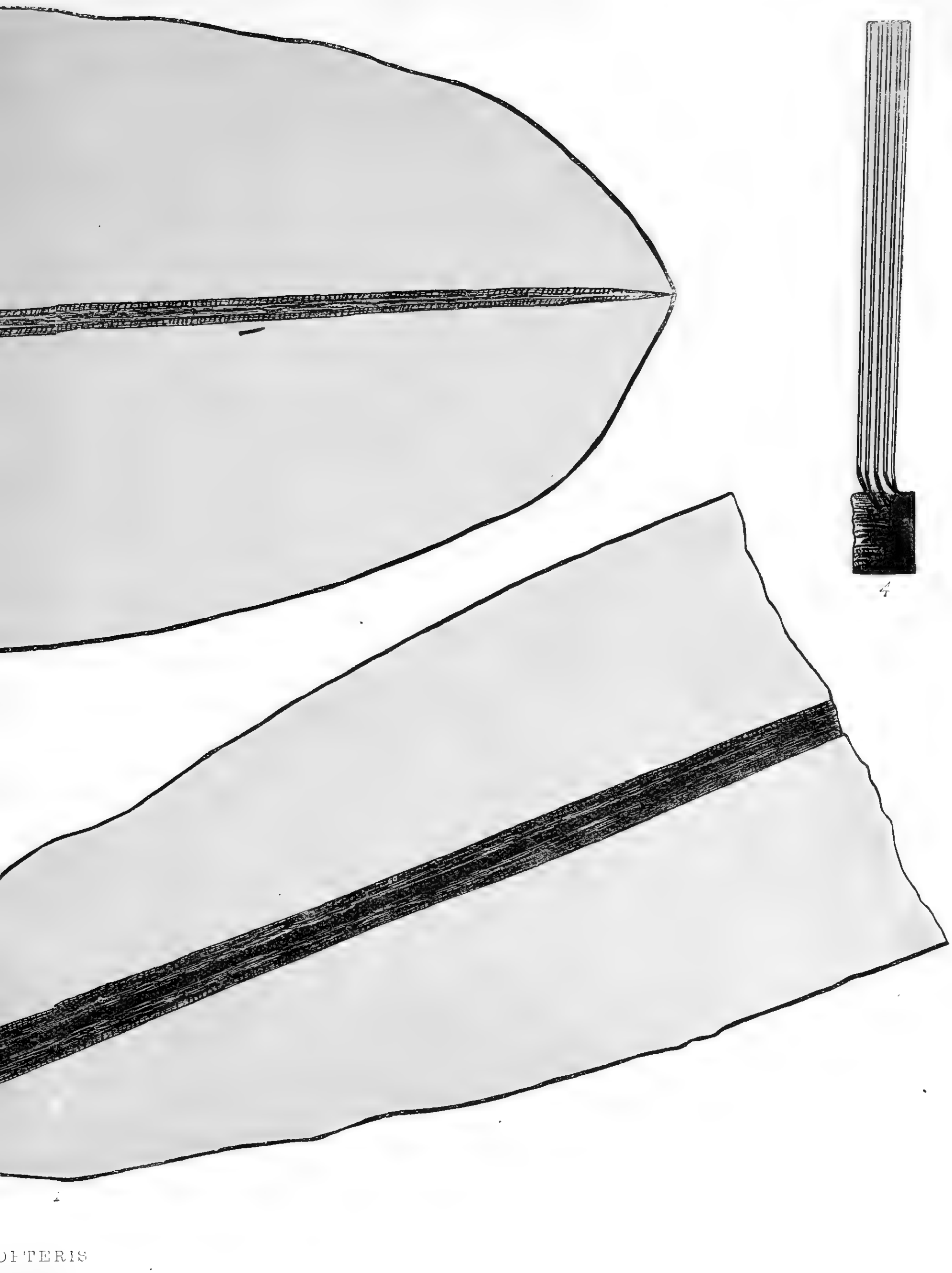


MACRO



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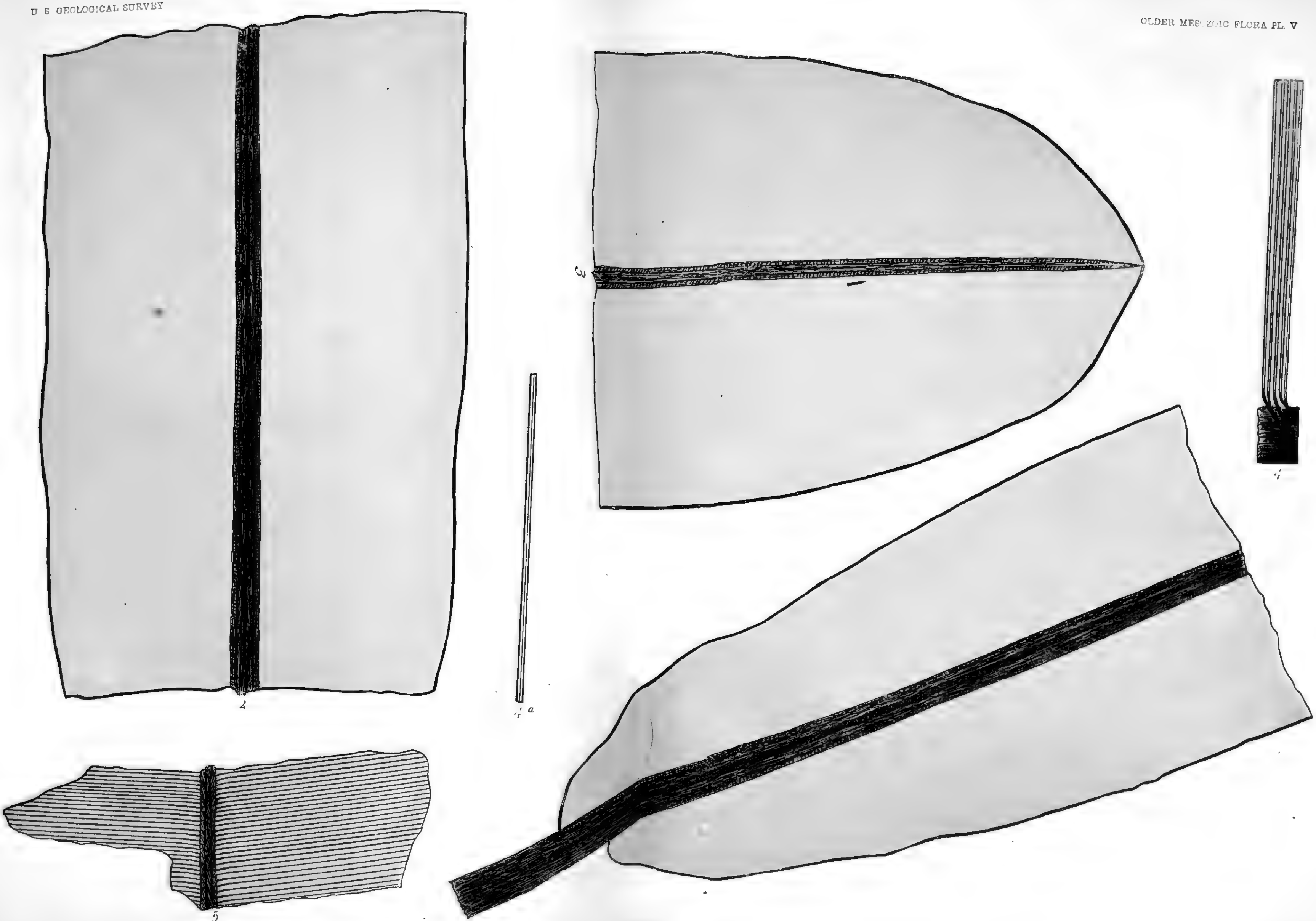
OPTERIS



MACROTÆNIOPTERIS.

PLATE VI.

FIGS. 1, 2. *Macrotæniopteris crassinervis*, Feist. Pages 22 to 23.

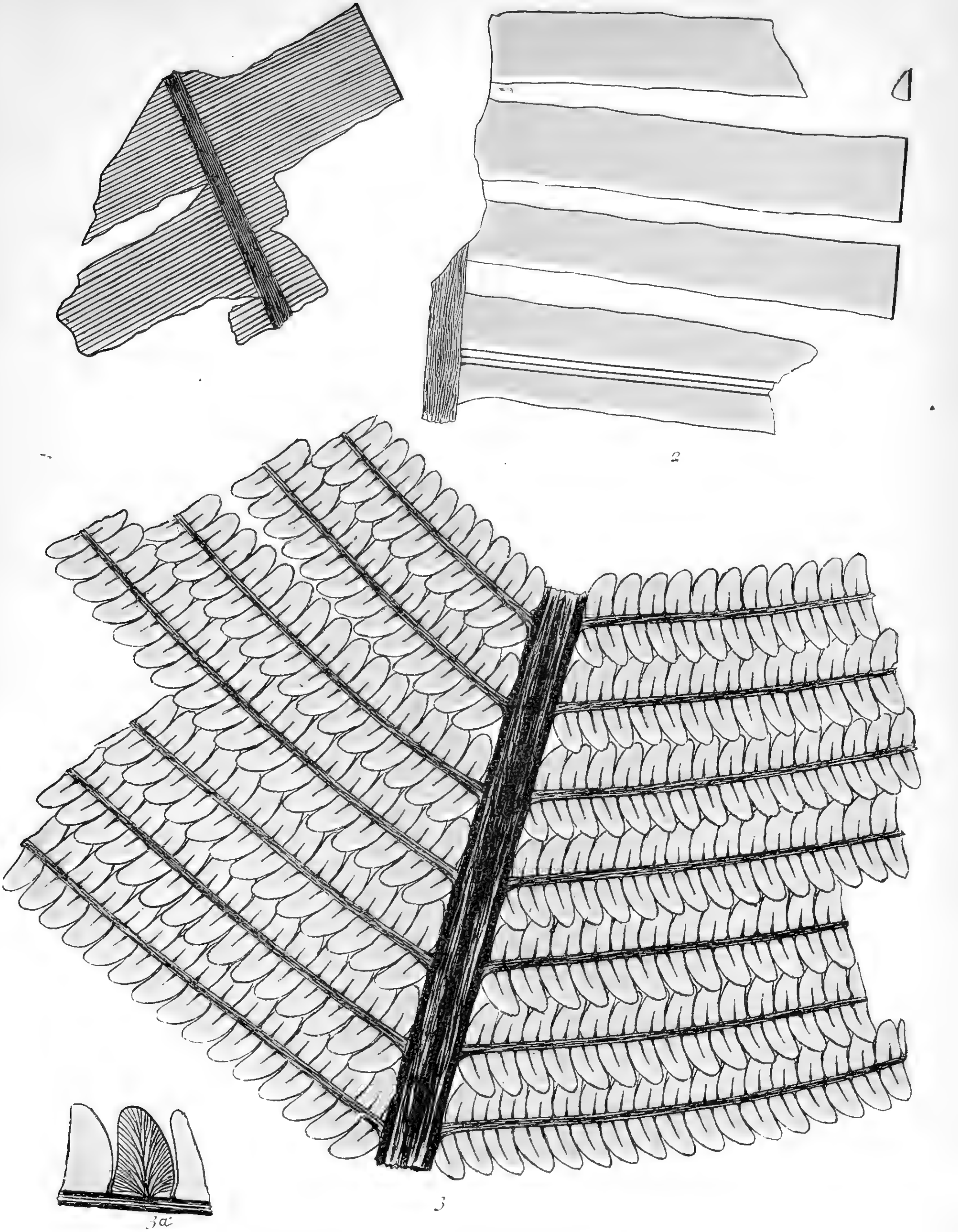
FIG. 1. A leaf of the smallest size.

FIG. 2. A leaf of the maximum size.

FIGS. 3, 3*a*. *Acrostichides linnææfolius* (Bunb. species). Pages 25 to 29.

FIG. 3. Represents a portion of a pinna from the lower part of a sterile frond.

FIG. 3*a*. Pinnule of the same magnified to show the nervation.



MACROTAENIOPTERIS ACROSTICHIDES

PLATE VII.

FIGS. 1–4. *Acrostichides linnææfolius* (Bunb. species). Pages 25 to 29.

FIG. 1. Ultimate pinnæ from the upper part of a large compound pinna, showing the pinnules, all sterile.

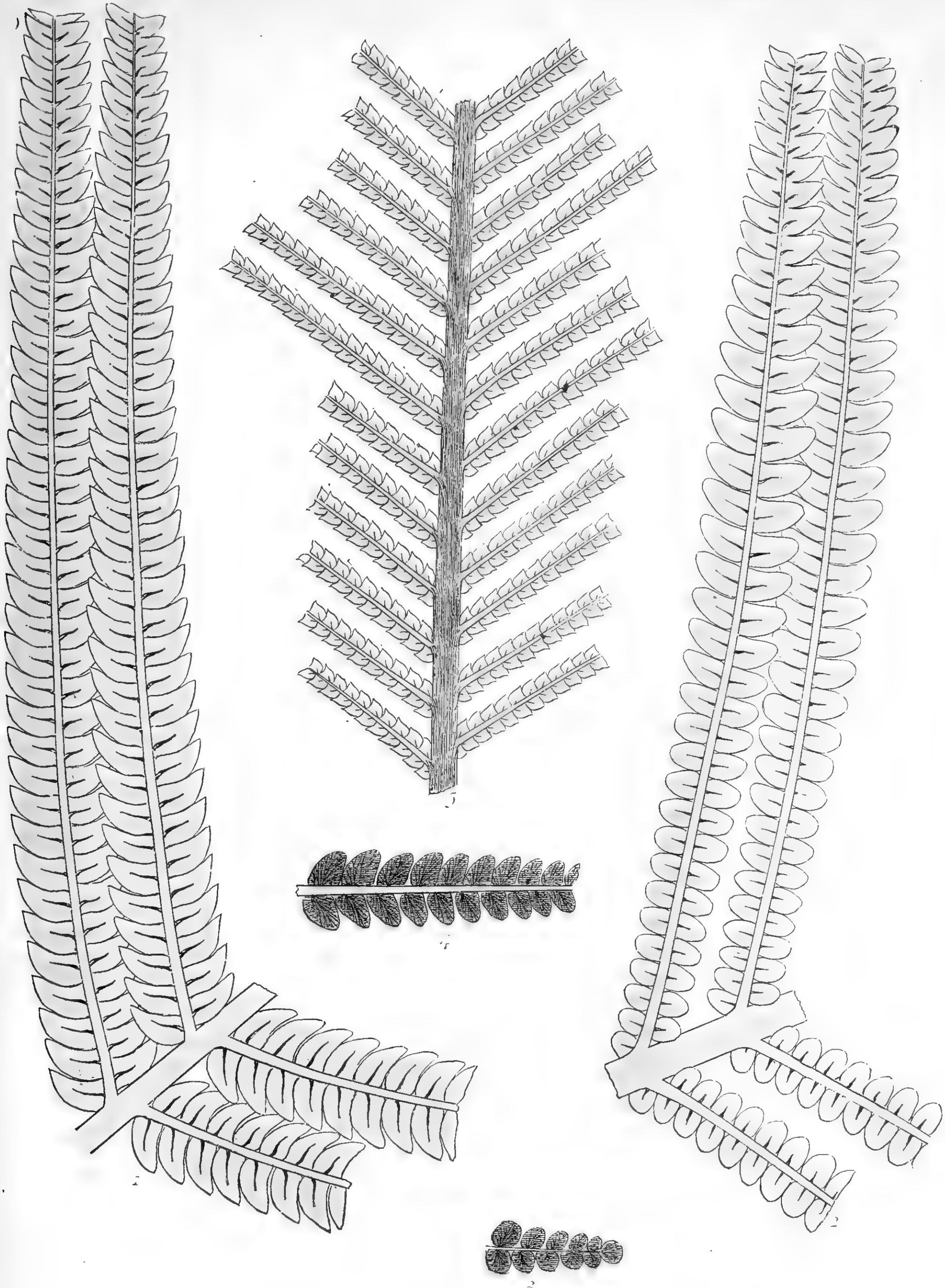
FIG. 2. Ultimate pinnæ from the lower part of the same compound pinna from which Fig. 1 was taken, showing fertile and sterile pinnules on the same pinna.

FIG. 3. Tip of a fertile ultimate pinna.

FIG. 4. Portion of a fertile ultimate pinna, showing the transition in form from sterile to fertile pinnules.

FIG. 5. *Acrostichides microphyllus*, spec. nov. Pages 33 to 34.

FIG. 5. Shows a portion of the lower part of the frond.



ACROSTICHIDES

PLATE VIII.

Figs. 1, 1*a*. ***Acrostichides linnææfolius*** (Bunb. species). Pages 25 to 29.

Fig. 1. A portion of a sterile compound pinna from the upper part of a frond.

Fig. 1*a*. Pinnules of Fig. 1 magnified to show nervation.

Figs. 2, 3*b*. ***Acrostichides rhombifolius***, spec. nov. Pages 29 to 32.

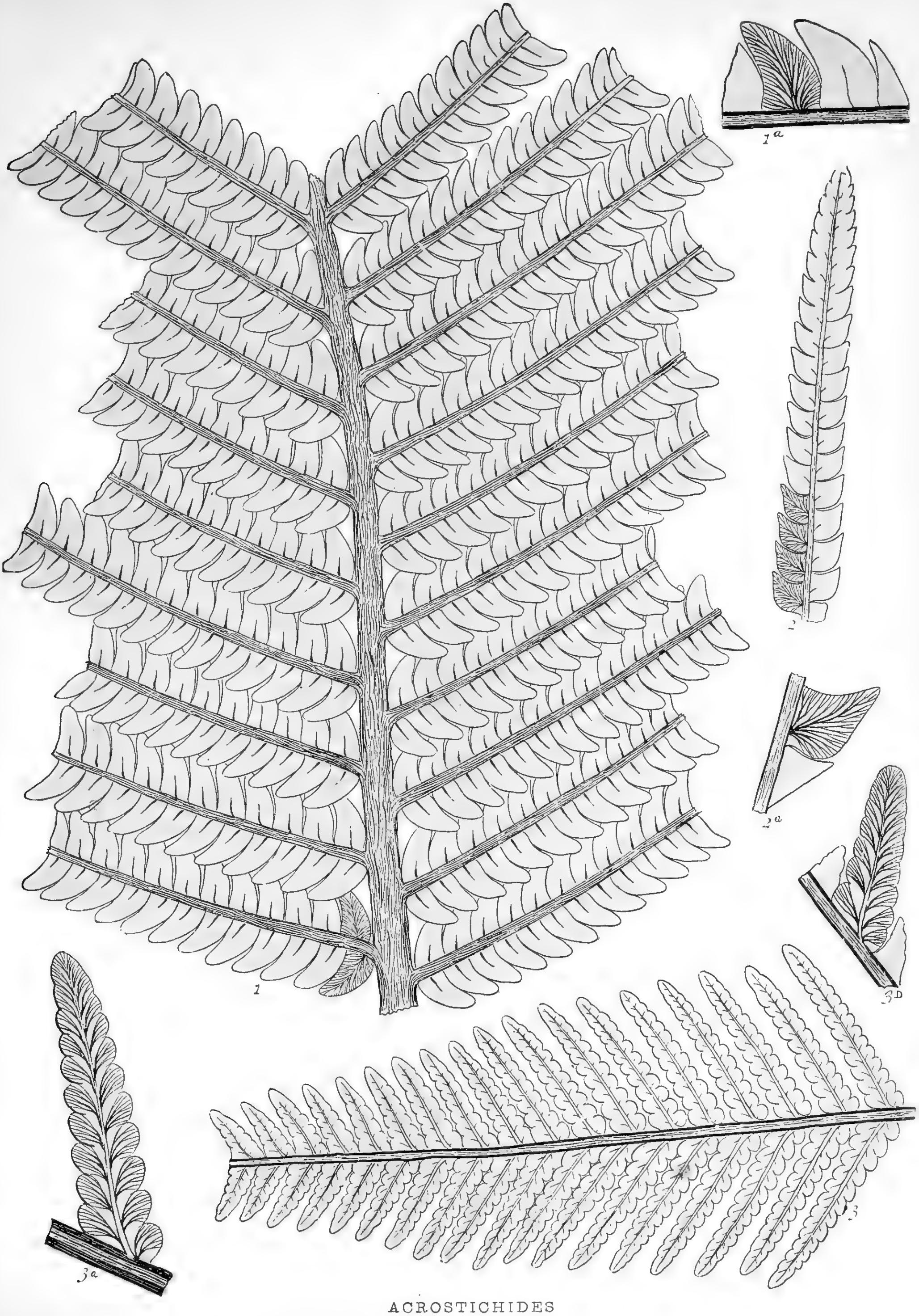
Fig. 2. Terminal portion of a large ultimate pinna.

Fig. 2*a*. Pinnule of Fig. 2 magnified to show nervation.

Fig. 3. Portion of the upper part of a compound pinna when the ultimate pinnæ are passing into pinnules.

Fig. 3*a*. Magnified pinna from the lower part of Fig. 3.

Fig. 3*b*. Magnified pinna from the upper part of Fig. 3.



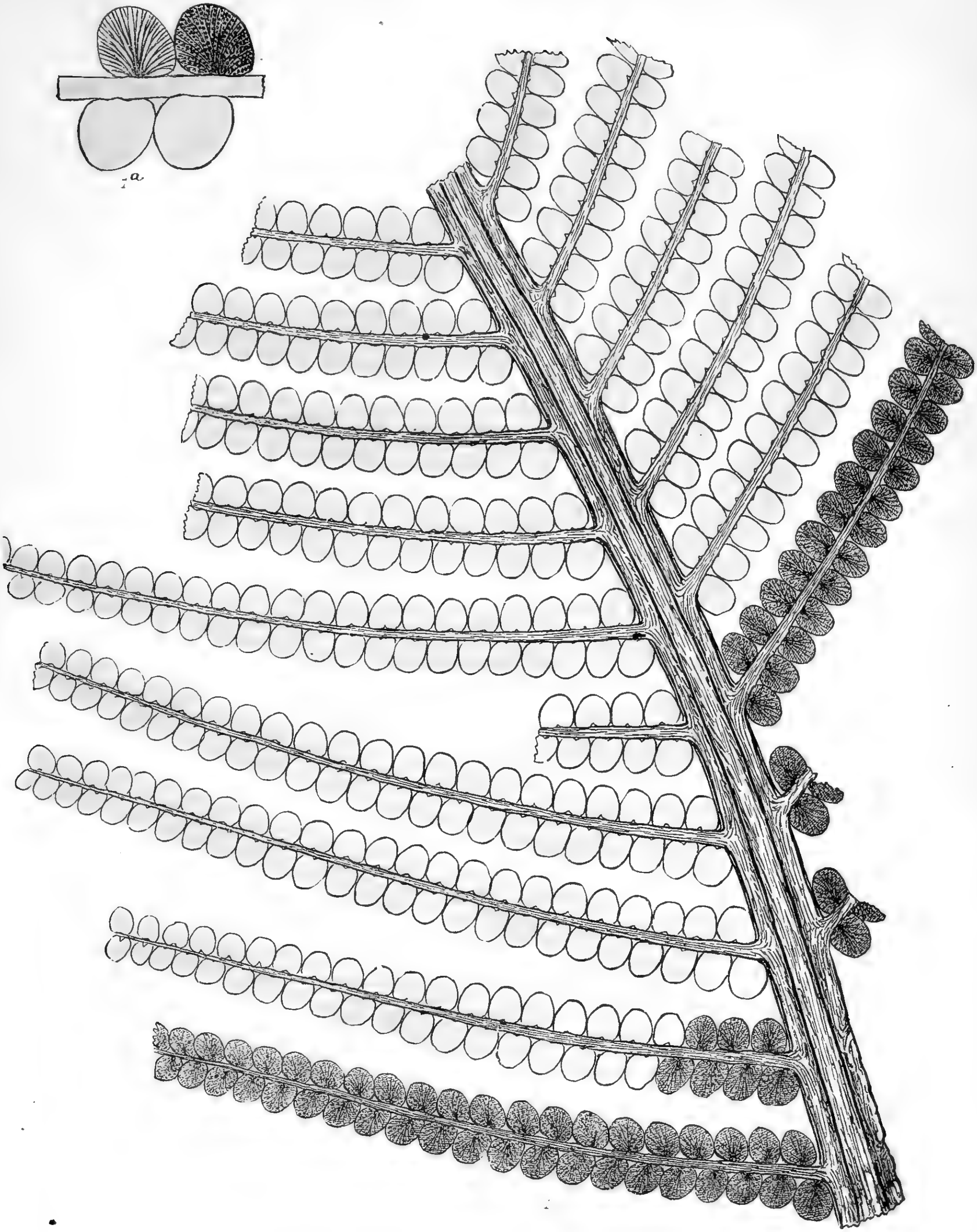
ACROSTICHIDES

PLATE IX.

FIGS. 1, 1*a*. *Acrostichides linnææfolius* (Bunb. species). Pages 25 to 29.

FIG. 1. A fertile compound pinna.

FIG. 1*a*. Pinnules of the same magnified to show fructification and nervation.



ACROSTICHIDES LINNÆIFOLIUS

PLATE X.

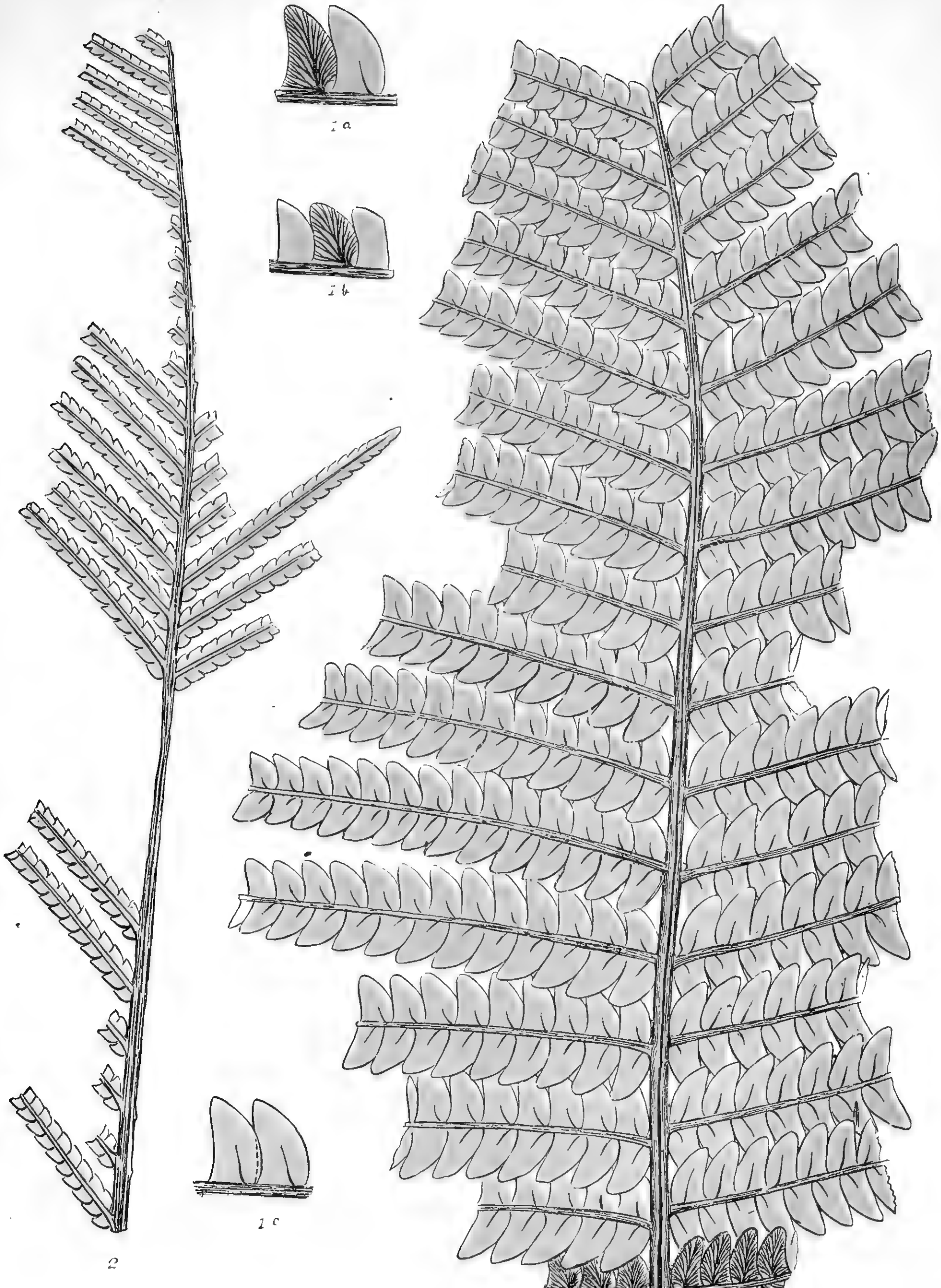
FIGS. 1, 1*a*, 1*b*, 1*c*. *Acrostichides densifolius*, spec. nov. Pages 34 to 35.

FIG. 1. Portion of the normal frond or compound pinna.

FIG. 1*a*. Magnified pinnules from the lower portion and Fig. 1*b* magnified pinnules from the upper portion of Fig. 1, to show nervation.

FIG. 1*c*. Pinnules of Fig. 1 magnified to show the partial imbrication.

FIG. 2. *Acrostichides microphyllus*, spec. nov. Pages 33 to 34. Shows a very slender variety of this species.



ACROSTICHIDES

PLATE XI.

FIGS. 1–3. *Acrostichides rhombifolius*, spec. nov. Pages 29 to 32.

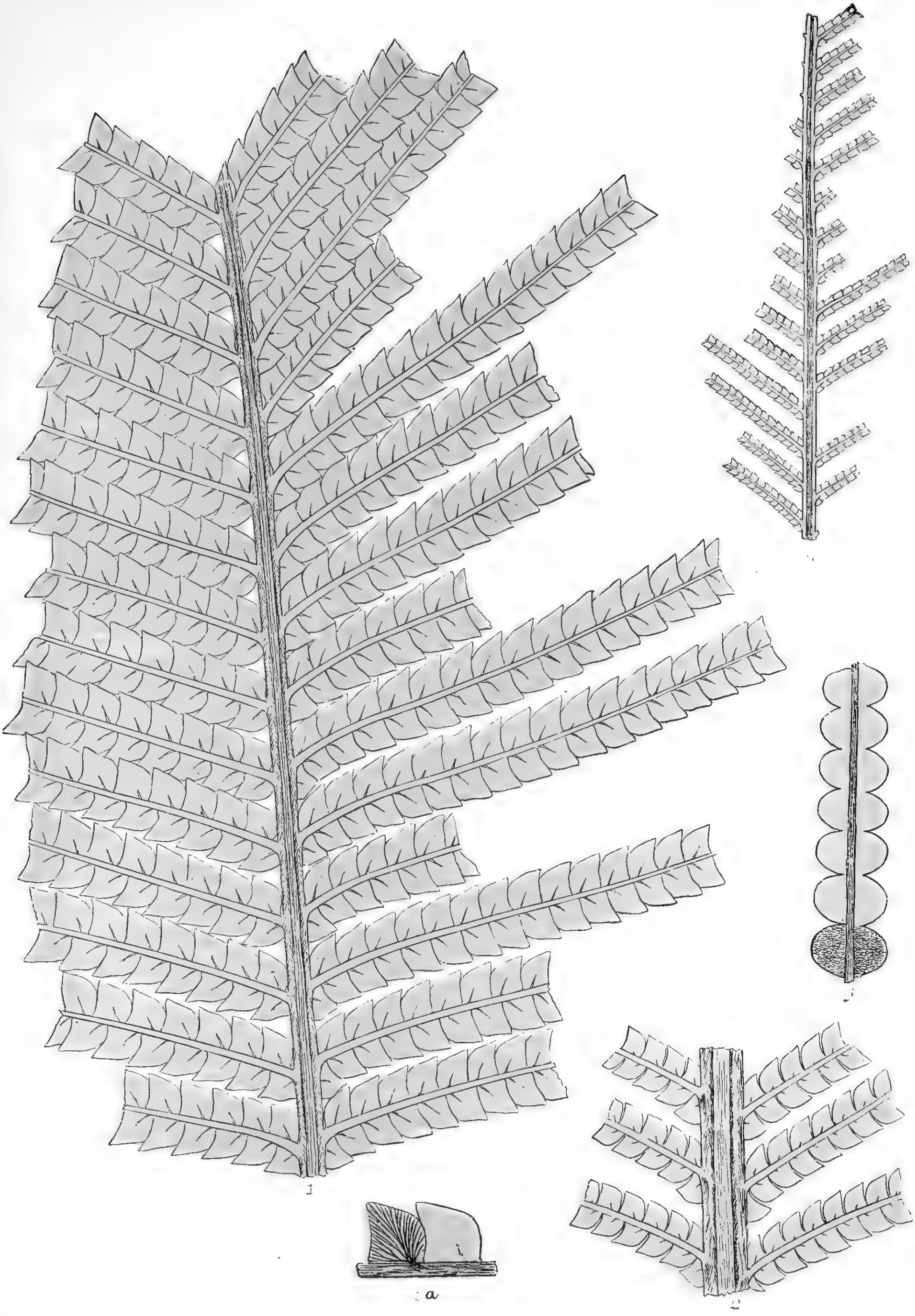
FIG. 1. Portion of a compound sterile pinna showing pinnules of the largest size.

FIG. 1*a*. Pinnules of the same magnified to show nervation.

FIG. 2. Portion of the lower part of a compound sterile pinna to show the small size of the pinnules there.

FIG. 3. Fragment of a fertile ultimate pinna showing abnormal form of pinnules.

FIG. 4. *Acrostichides microphyllus*, spec. nov. Pages 33 to 34. Shows a very slender variety of this species that is not uncommon.



ACROSTICHIDES

PLATE XII.

FIGS. 1, 2. *Acrostichides rhombifolius*, spec. nov. Pages 29 to 32.

FIG. 1. A common form of the sterile pinnules with prolonged tips.

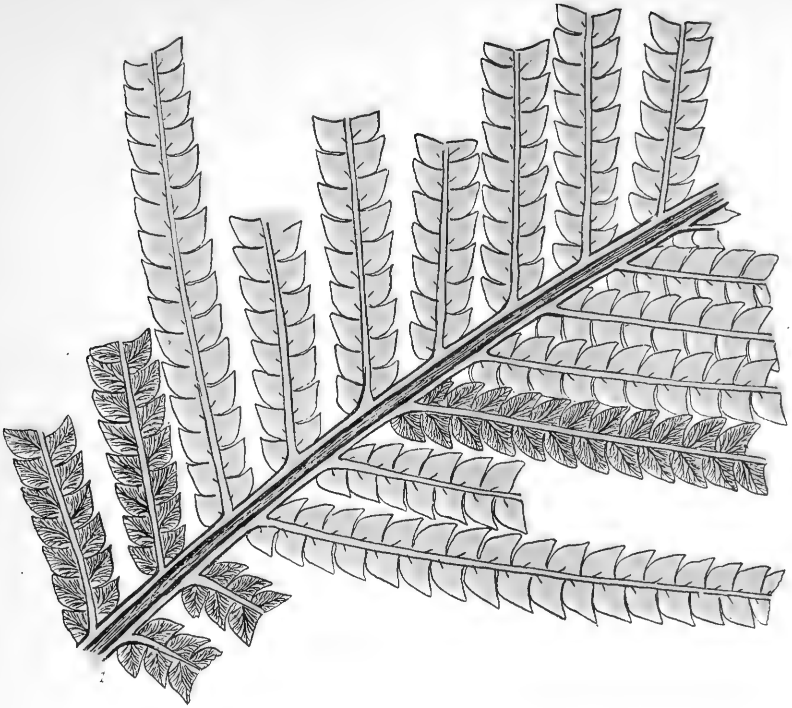
FIG. 1 *a*. Pinnules of Fig. 1 magnified to show nervation.

FIG. 2. Portion of the upper part of a compound sterile pinna, where the ultimate pinna are becoming simply lobed.

FIGS. 3, 3 *a*. *Acrostichides microphyllus*, spec. nov. Pages 33 to 34.

FIG. 3. Gives the largest form seen of this species.

FIG. 3 *a*. Pinnule of Fig. 3, magnified to show nervation.



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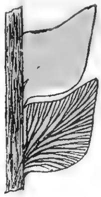
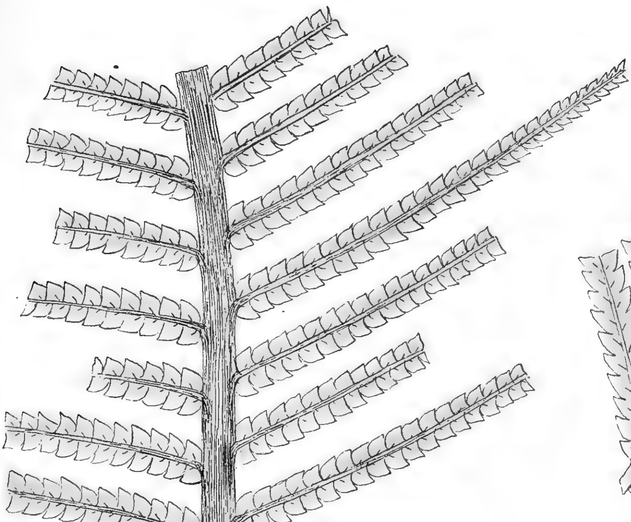
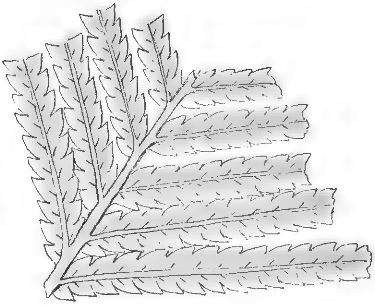


1 a



3



2

3 a

ACROSTICHIDES

PLATE XIII.

FIGS. 1, 2. *Acrostichides rhombifolius*, spec. nov. Pages 29 to 32.

FIG. 1. Represents the upper part of a compound sterile pinna where the pinnæ have become simple pinnules.

FIG. 1 *a*. Pinnule of Fig. 1 magnified to show nervation.

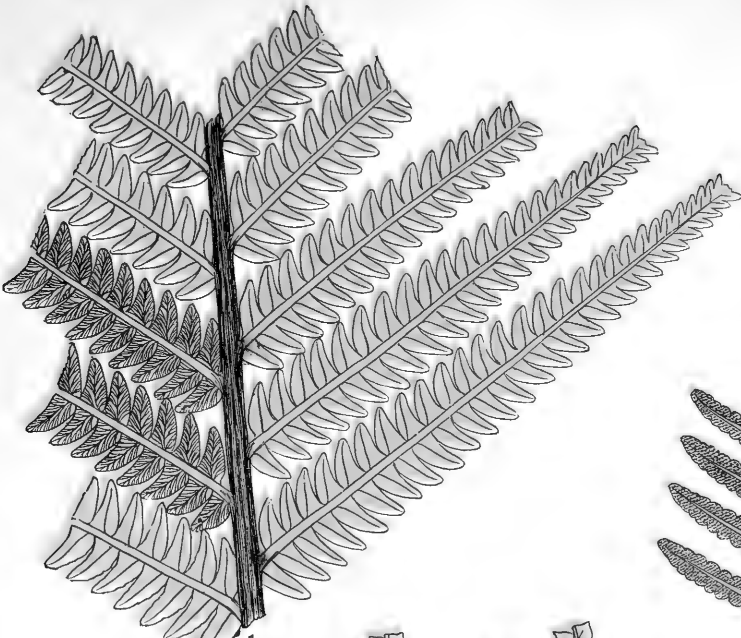
FIG. 2. Upper portion of a compound fertile pinna where the ultimate pinnæ are simply lobed.

FIGS. 3, 3 *a*, 3 *b*. *Acrostichides rhombifolius*, var. *rarinervis*. Pages 32 to 33.

FIG. 3. Portion of a normal, sterile, compound pinna.

FIG. 3 *a*. Pinnules from the lower part of Fig. 3.

FIG. 3 *b*. Pinnules from the upper part of Fig. 3 magnified to show nervation.



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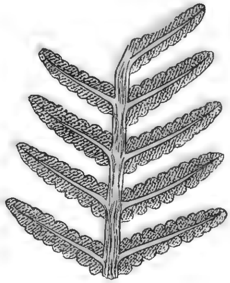
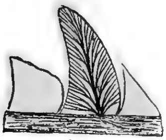
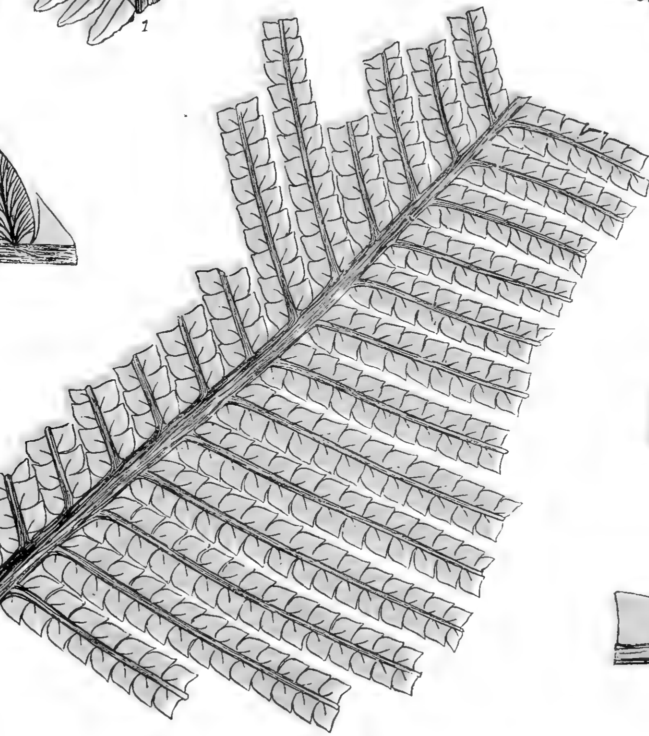


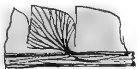
2



1 a



3



3 b

3 a

ACROSTICHIDES

PLATE XIV.

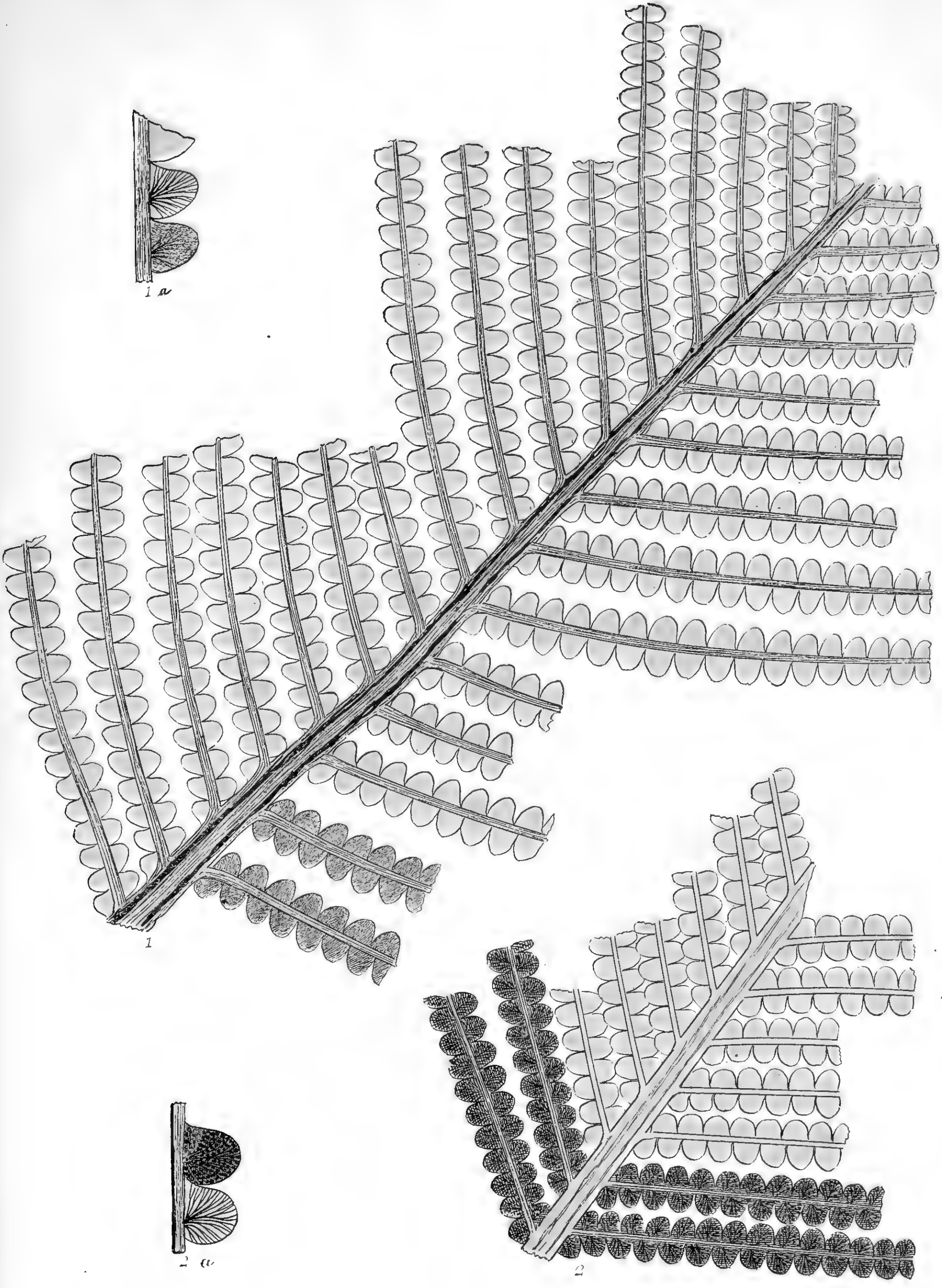
FIGS. 1, 2 *a*. *Acrostichides rhombifolius*, spec. nov. Pages 29 to 32.

FIG. 1. Fragment of a large fertile compound pinna of common occurrence.

FIG. 1 *a*. Pinnules of Fig. 1 magnified to show nervation and fructification.

FIG. 2. Fragment of a compound fertile pinna showing pinnules more rounded than those of Fig. 1; also common.

FIG. 2 *a*. Pinnules of Fig. 2 magnified to show nervation and fructification.



ACROSTICHIDES RHOMBIFOLIUS

PLATE XV.

FIGS. 1, 1 *a*. *Mertensides distans*, spec. nov. Pages 39 to 40.

FIG. 1. Portion of a compound pinna of the normal kind.

FIG. 1 *a*. Pinnules of Fig. 1 magnified to show the fructification.

FIGS. 2–5. *Mertensides bullatus* (Bunb. species). Pages 35 to 39.

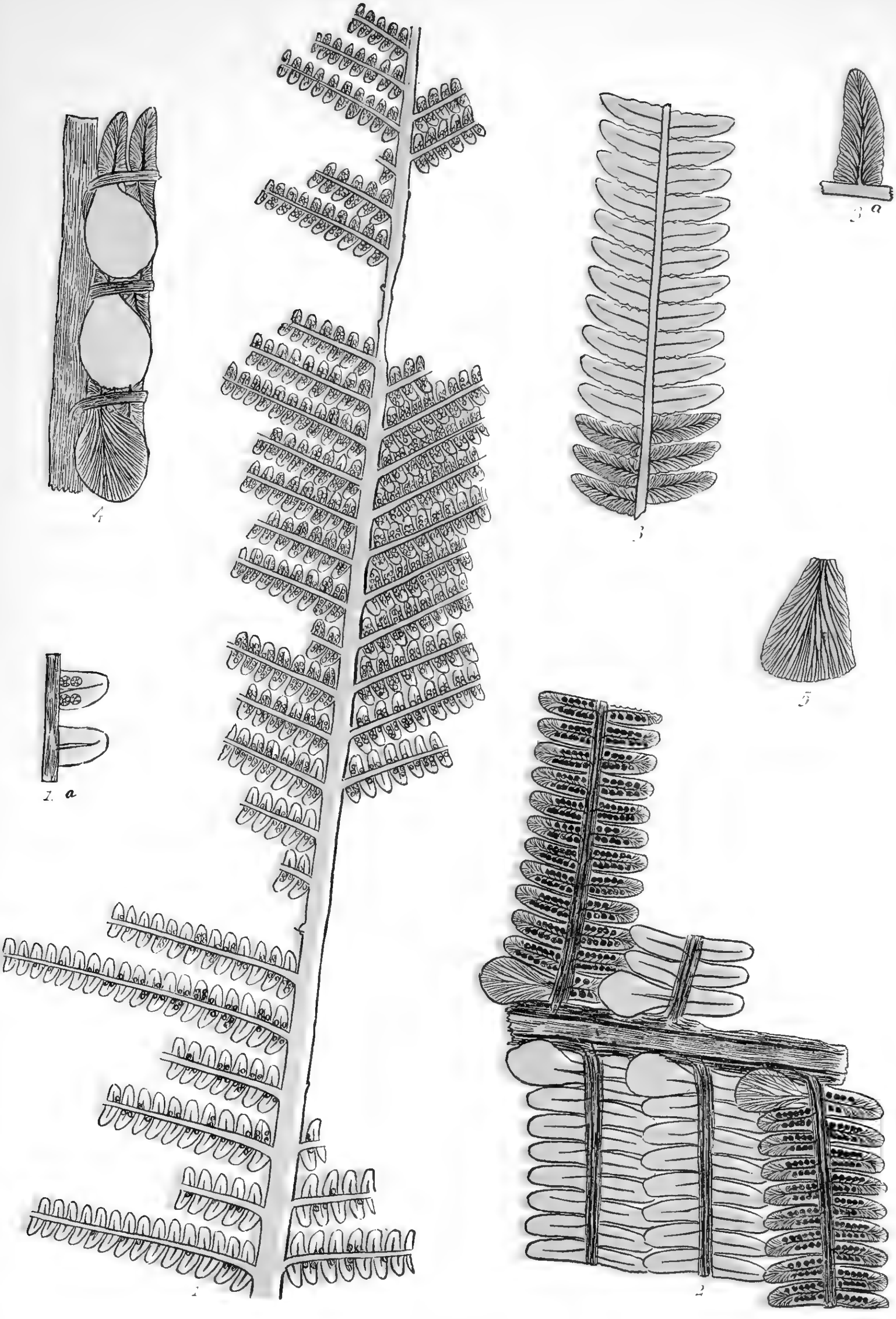
FIG. 2. Portion of a compound fertile pinna of the most common kind, taken from the lower part of the pinna.

FIG. 3. Portion of an ultimate sterile pinna, taken from the lower part of the compound pinna.

FIG. 3 *a*. Pinnule of Fig. 3 magnified to show nervation.

FIG. 4. Portion of a compound sterile pinna, showing large heteromorphous pinnules.

FIG. 5. Portion of a heteromorphous pinnule of the largest size.



MERTENSIDES

PLATE XVI.

FIGS. 1–3. *Mertensides bullatus* (Bunb. species). Pages 35 to 39.

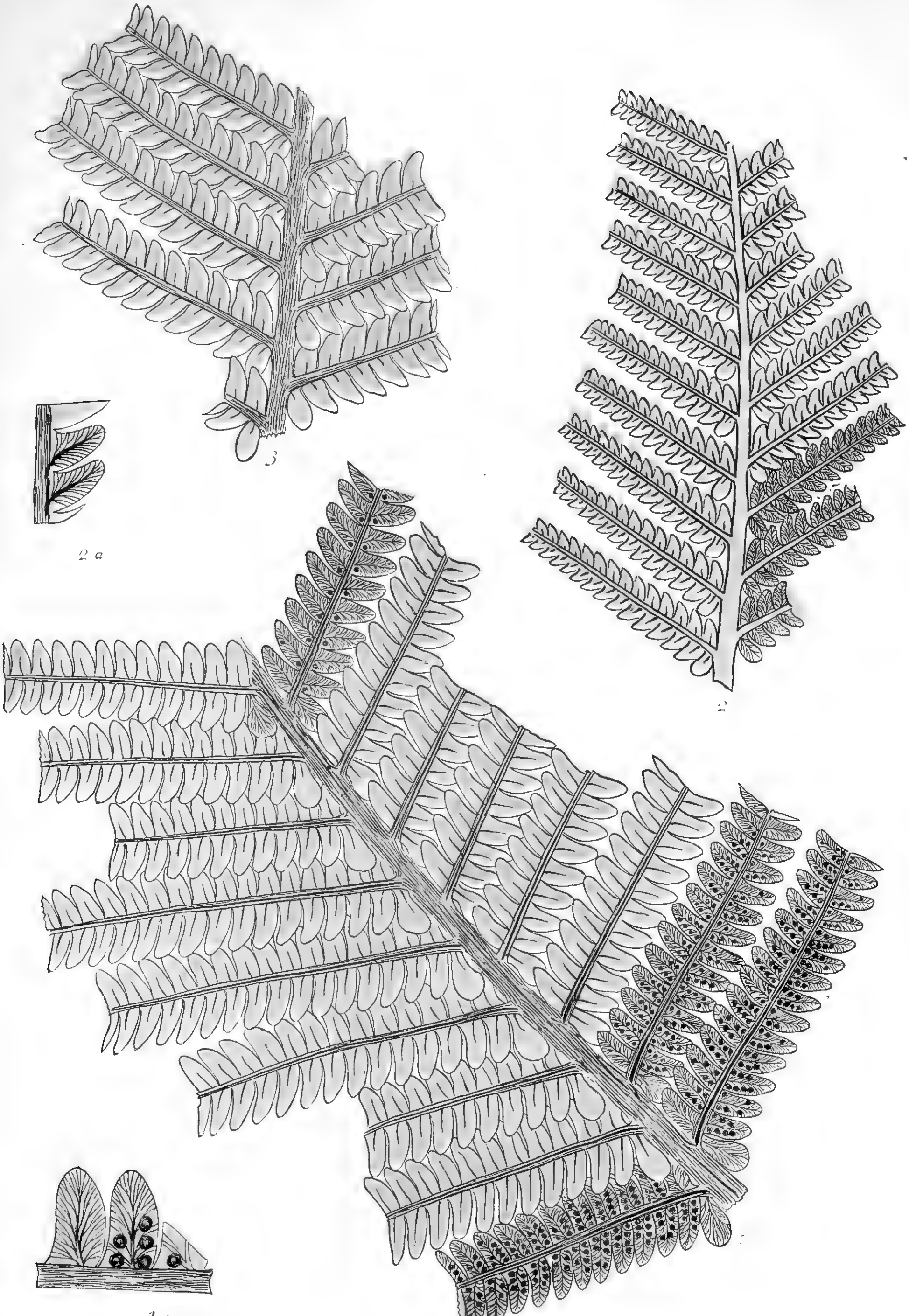
FIG. 1. Portion of a compound fertile pinna, showing the diminution in number of the sori towards the summit of the pinna.

FIG. 1*a*. Pinnules of Fig. 1 magnified to show the fructification and nervation.

FIG. 2. Portion of the upper part of a compound sterile pinna showing uncommon form of the pinnules.

FIG. 2*a*. Pinnules of Fig. 2 magnified to show nervation.

FIG. 3. Portion of a compound sterile pinna showing an unusual form for the pinnules.



MERTENSIDES BULLATUS

PLATE XVII.

FIGS. 1–2 *a*. *Mertensides bullatus* (Bunb. species). Pages 35 to 39.

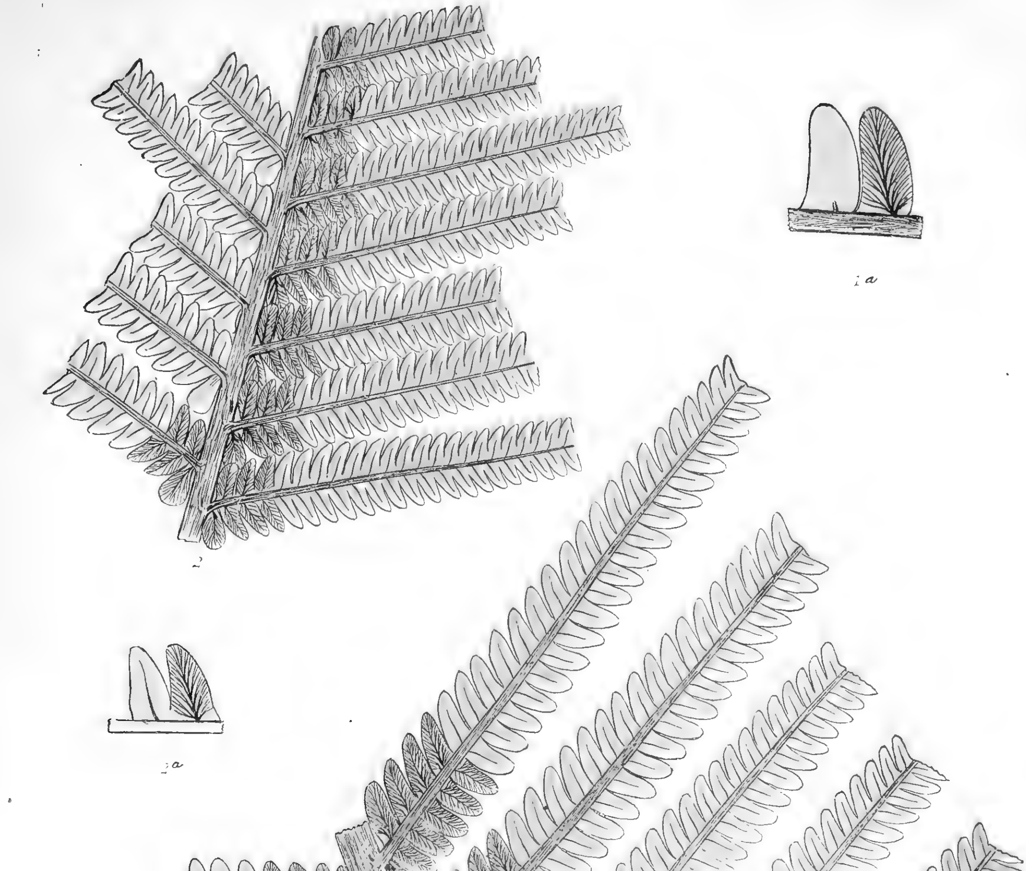
FIG. 1. Portion of the lower part of a compound sterile pinna.

FIG. 1 *a*. Pinnules of Fig. 1, magnified to show nervation.

FIG. 1 *b*. Heteromorphous pinnule of Fig. 1, magnified.

FIG. 2. Upper portion of a compound sterile pinna.

FIG. 2 *a*. Pinnules of Fig. 2, magnified to show nervation.



2

1 a

2 a

1 b

1

MERTENSIDES BULLATUS

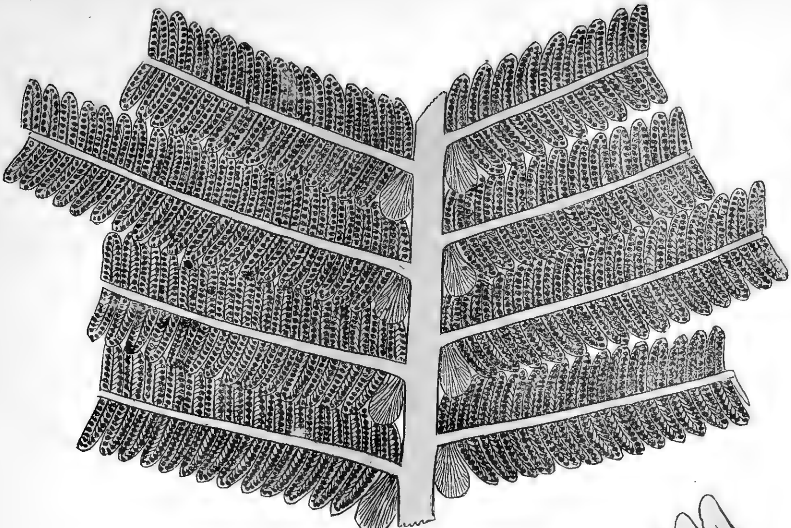
PLATE XVIII.

FIGS. 1, 2 *a*. *Mertensides bullatus*, (Bunb. species). Pages 35 to 39.

FIG. 1. Portion of the lower part of a compound fertile pinna, showing the pinnules with undulate margins, and the increase of sori towards the middle and summit portions of the ultimate pinnæ.

FIG. 2. Portion of a compound fertile pinna with fully fructified pinnules. A common form.

FIG. 2 *a*. Pinnules of Fig. 2, magnified to show the fructification.



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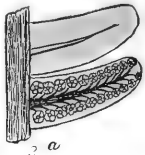
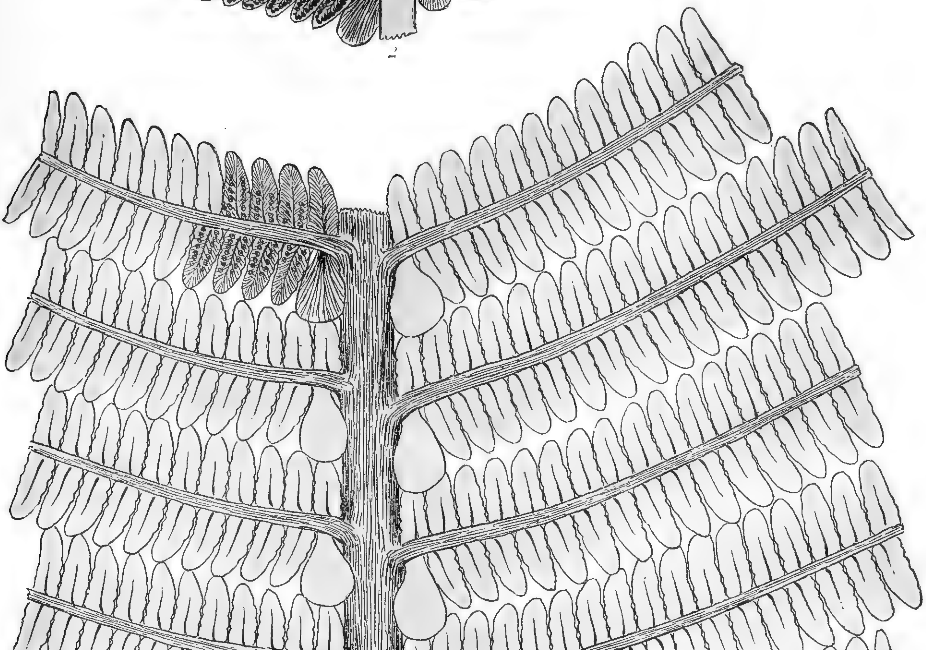


2 a



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MERTENSIDES BULLATUS

PLATE XIX.

FIG. 1. *Mertensides bullatus* (Bunb. species). Pages 35 to 39. Portion of a fertile compound pinna, showing the sori and nervation as seen when the upper surface of the plant is presented to view.

FIGS. 2–5. *Asterocarpus Virginiensis*, spec. nov. Pages 41 to 45.

FIG. 2. Portion of the lower part of a compound sterile pinna, showing deeply-lobed pinnules.

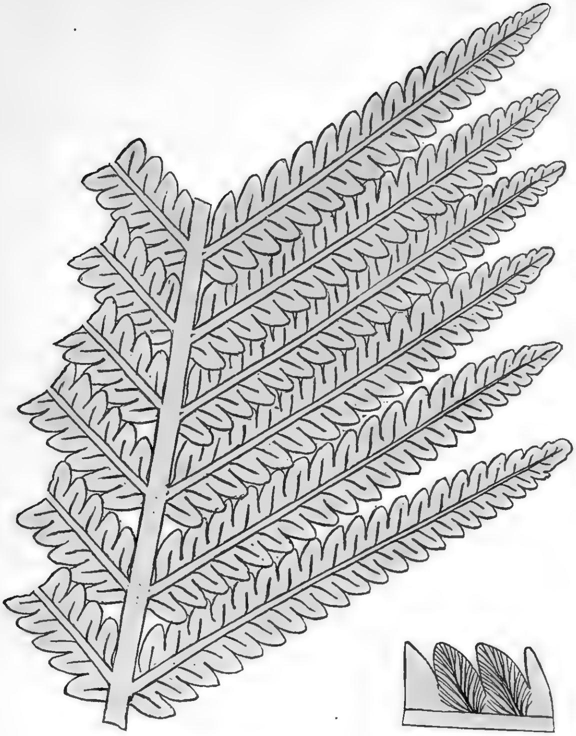
FIG. 2 *a*. Portion of Fig. 2, magnified to show nervation.

FIG. 3. Upper part of a sterile pinna, showing partially united pinnules.

FIG. 4. Portion of a sterile pinna, with pinnules having a very broad midrib.

FIG. 5. Summit of a sterile pinna.

5



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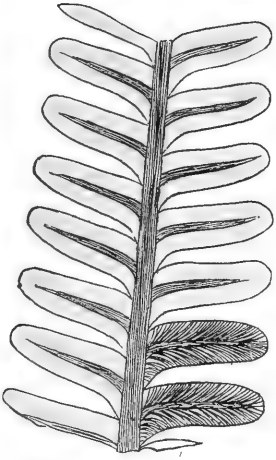
2a



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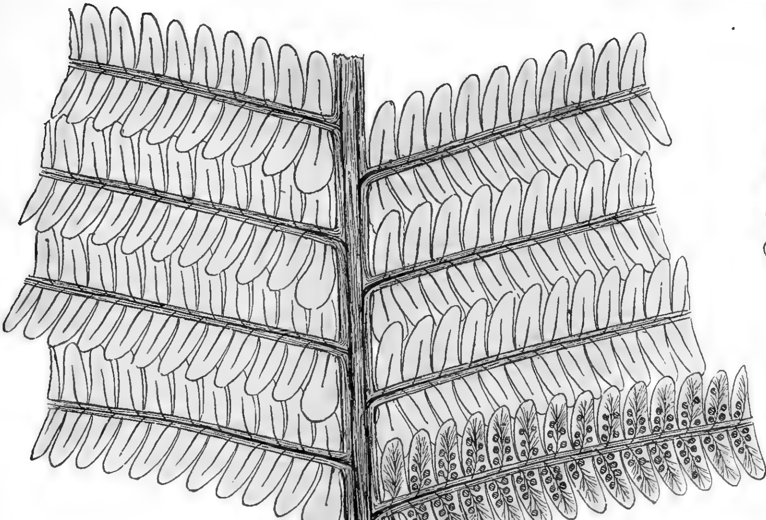


1

3

MERTENSIDES—ASTEROCARPUS

PLATE XX.

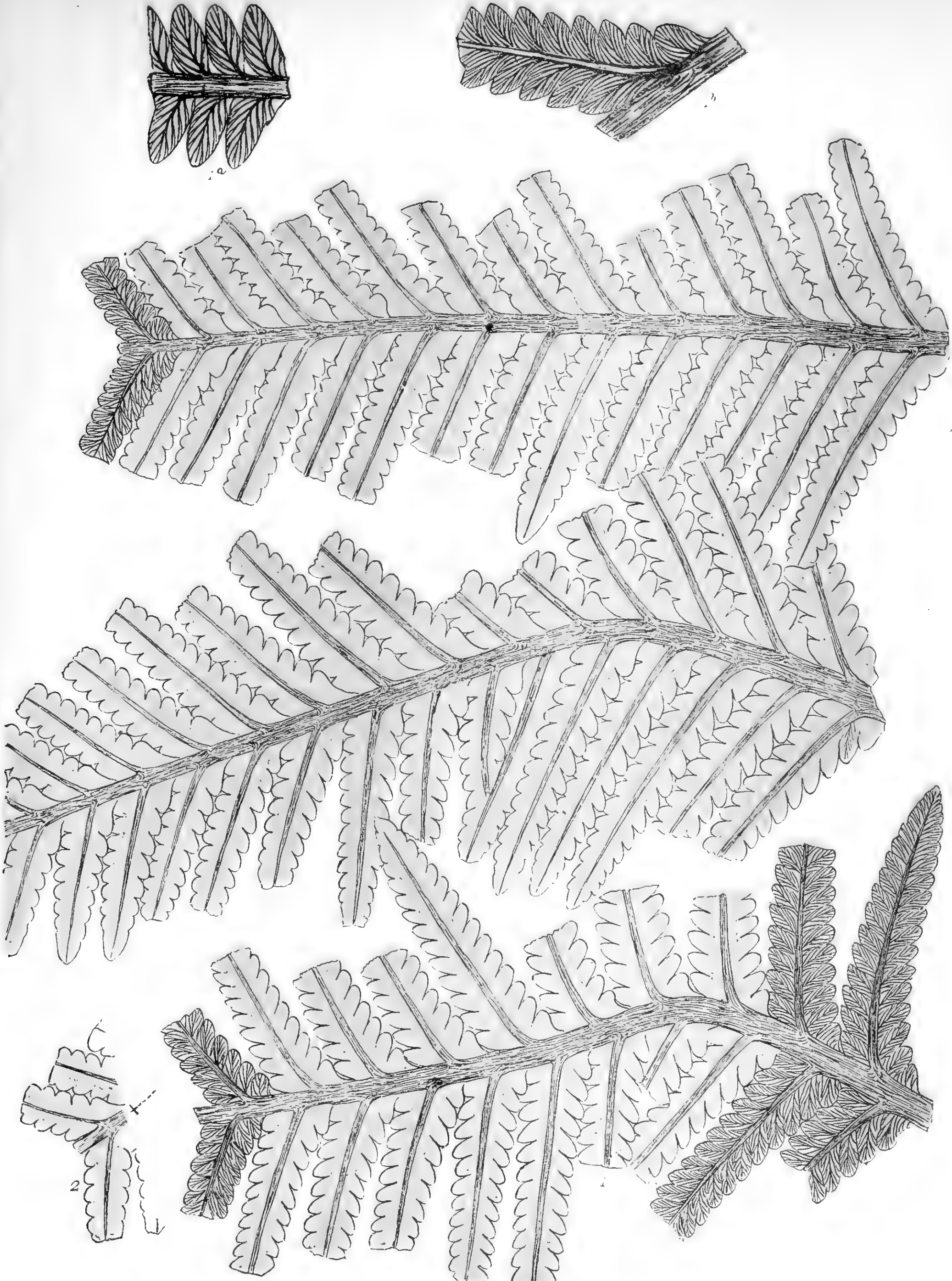
Figs. 1, 2. *Asterocarpus Virginiensis*, spec. nov. Pages 41 to 45.

Fig. 1. Three compound sterile pinnæ, that were once attached to a common rachis, showing the gradation in depth and shape of the lobes, from the lower to the upper and summit portions.

Fig. 1 *a*. Portion of the lower part of the lower compound pinna, magnified to show nervation.

Fig. 1 *b*. Portion of the summit of the uppermost compound pinna, magnified to show nervation.

Fig. 2. Summit of the middle compound pinna.



ASTEROCARPUS VIRGINIENSIS

PLATE XXI.

FIGS. 1, 2. *Asterocarpus Virginiensis*, spec. nov. Pages 41 to 45.

FIG. 1. Several compound sterile pinnæ that were once attached to a common rachis, showing the diminishing depth of the lobes from base to summit.

FIG. 1*a*. Portion of a lower pinnule of Fig. 1, magnified to show the nervation.

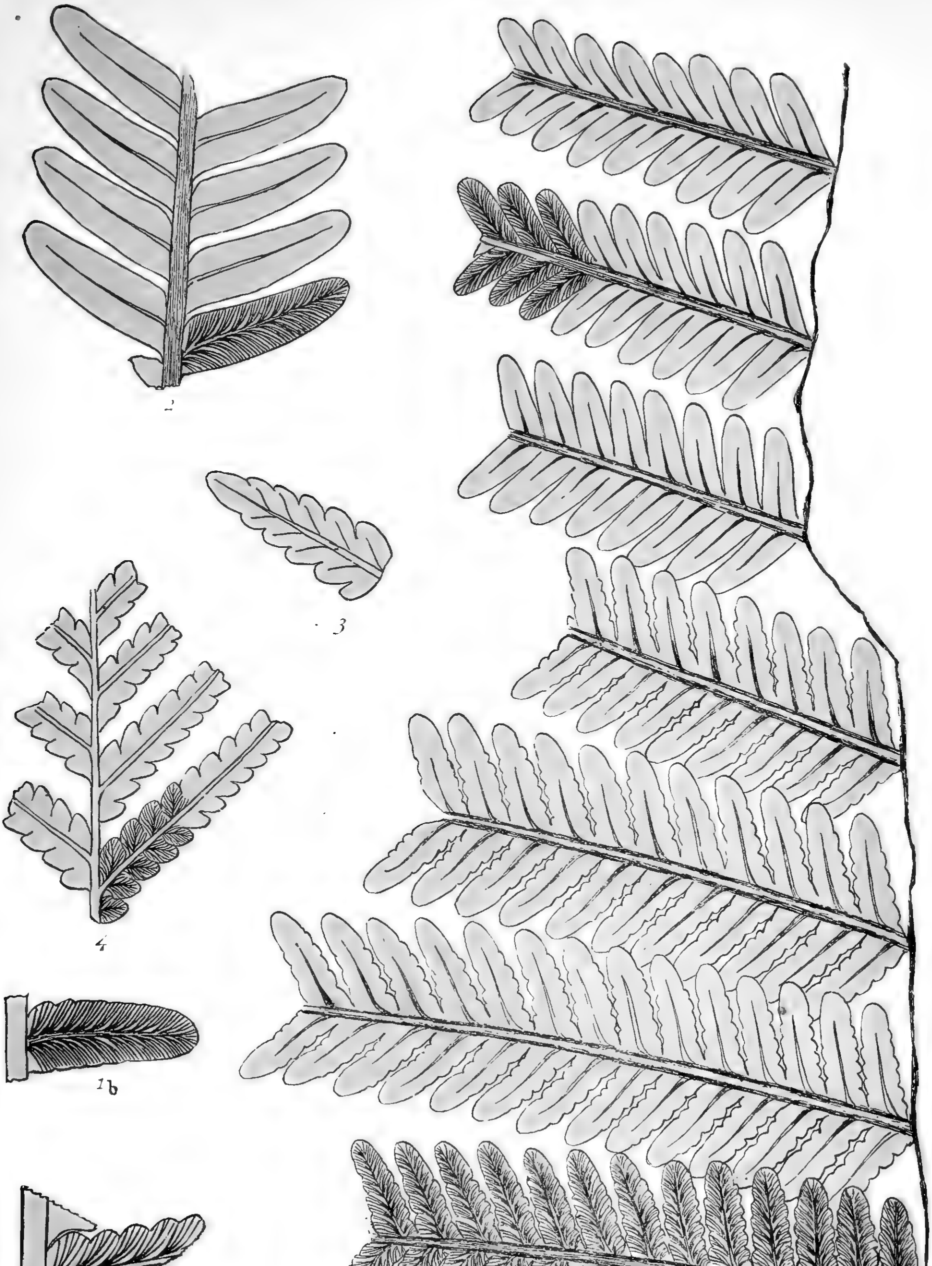
FIG. 1*b*. Pinnule from the upper part of Fig. 1, magnified to show nervation.

FIG. 2. Portion of a sterile pinna with large, broad pinnules.

FIGS. 3, 4. *Asterocarpus Virginiensis*, var. *obtusilobus*. Page 45 to 46.

FIG. 3. Summit of a sterile ultimate pinna magnified.

FIG. 4. Upper part of a compound sterile pinna.



ASTEROCARPUS

PLATE XXII.

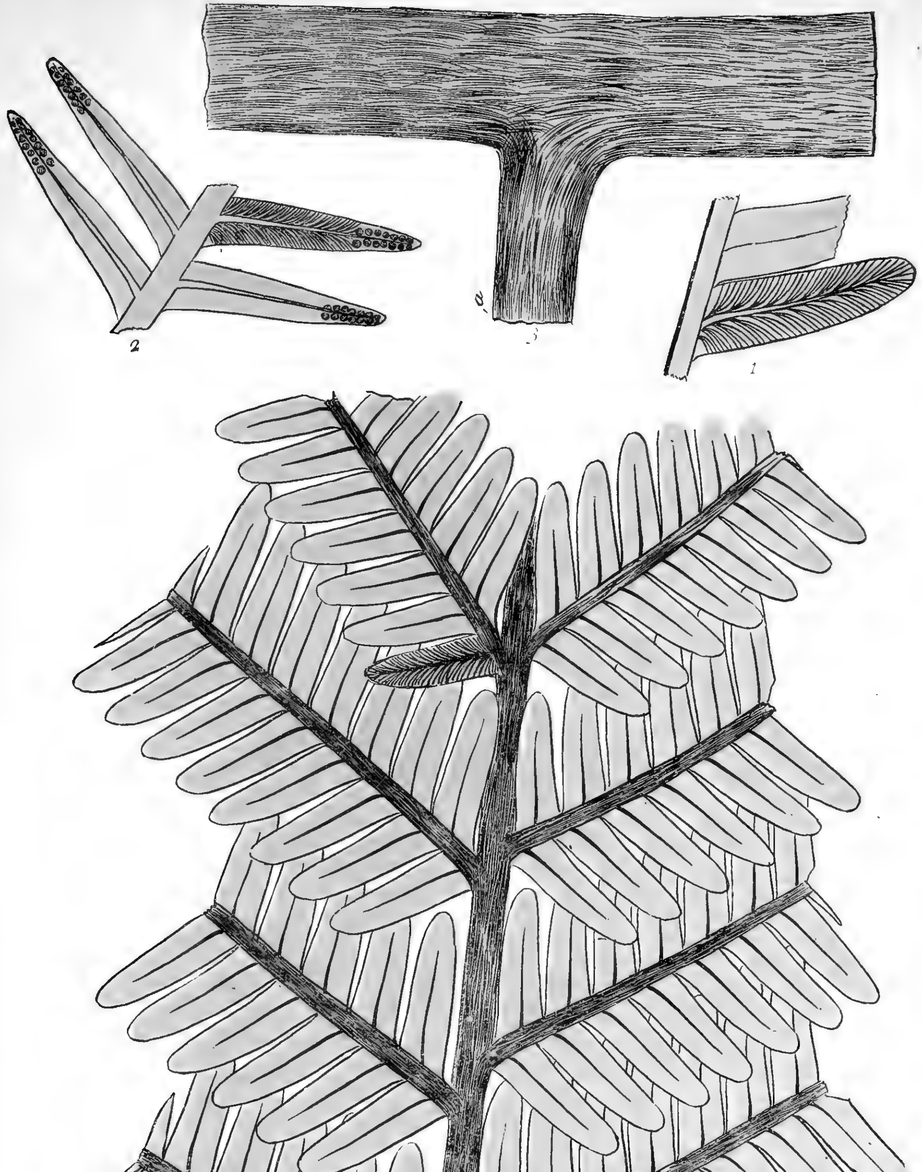
FIGS. 1–3. *Asterocarpus Virginiensis*, spec. nov. Pages 41 to 45.

FIG. 1. Portion of a sterile compound pinna with large pinnules. A common form.

FIG. 1 *a*. Pinnule of Fig. 1, magnified to show nervation.

FIG. 2. Portion of a compound pinna showing fructification only at the tips of the pinnules.

FIG. 3. Portion of the stipe.



ASTEROCARPUS VIRGINIENSIS

PLATE XXIII.

FIGS. 1–4 *a*. *Asterocarpus Virginiensis*, spec. nov. Pages 41 to 45.

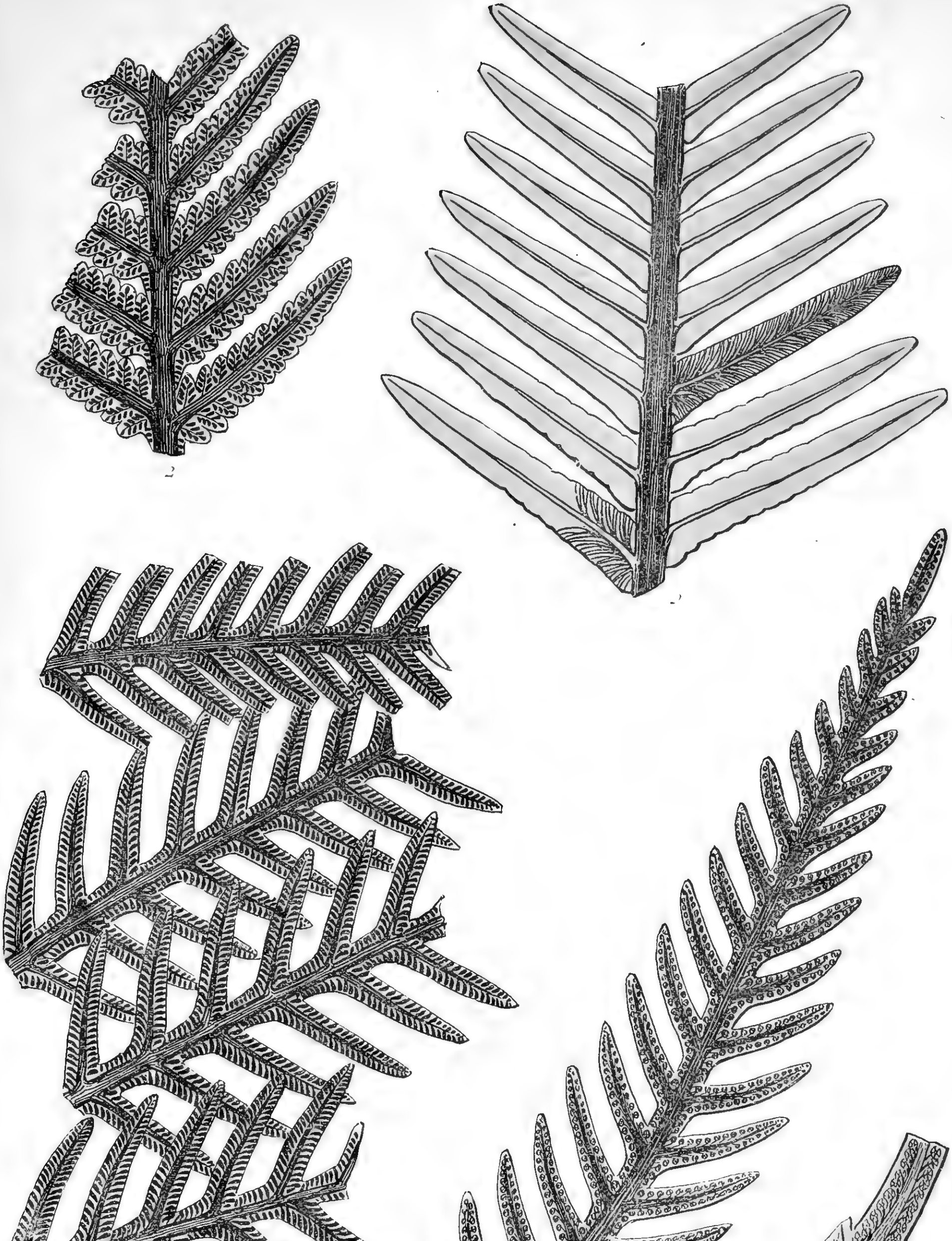
FIG. 1. Several fertile pinnæ that were once attached to a common rachis, seen from the upper surface with the sori showing through the leaf substance of the pinnules.

FIG. 2. Portion of the lower part of a compound fertile pinna, seen as in Fig. 1.

FIG. 3. Portion of a compound sterile pinna showing unusually large pinnules with undulate margins.

FIG. 4. Portion of a fertile pinna seen from the under side and showing the true form of the sori.

FIG. 4 *a*. Portion of the pinnule of Fig. 4, magnified to show the form of the sori.



ASTEROCARPUS VIRGINIENSIS

PLATE XXIV.

FIGS. 1, 2*a*. *Asterocarpus Virginiensis* ? spec. nov. Page 42.

FIG. 1. Portion of a compound fertile pinna of perhaps a variety of *A. Virginiensis.*

FIG. 2. Fragment of a larger form of the same plant.

FIG. 2*a*. Pinnules of Fig. 2, magnified to show the sori.

FIGS. 3–5*a*. *Asterocarpus Virginiensis*, var. *obtusilobus*. Pages 45 to 46.

FIG. 3. Portion of a sterile compound pinna of the normal form.

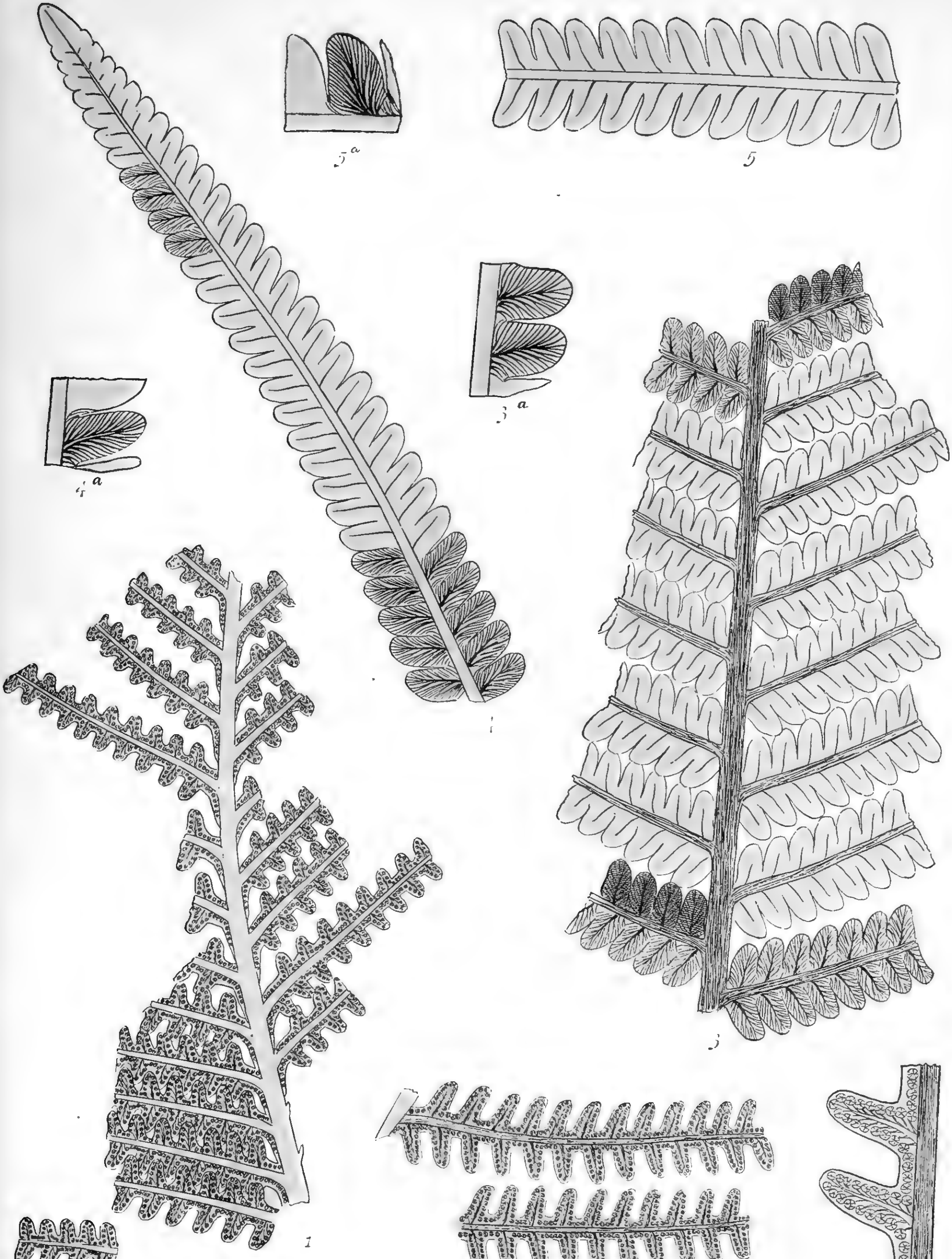
FIG. 3*a*. Pinnules of Fig. 3, magnified to show the nervation.

FIG. 4. Portion of a long sterile ultimate pinna.

FIG. 4*a*. Pinnule of Fig. 4 magnified.

FIG. 5. Ultimate sterile pinna with broad deep lobes.

FIG. 5*a*. Pinnule of Fig. 5 magnified.



ASTEROCARPUS

PLATE XXV.

FIGS. 1 *b*, 1 *a*. *Asterocarpus Virginiensis*, var. *obtusilobus*. Pages 45 to 46.

FIG. 1. Shows a form with broad rounded lobes and a fine, closely crowded nervation.

FIG. 1 *a*. Pinnules of Fig. 1, magnified to show the nervation.

FIGS. 2–6. *Asterocarpus platyrachis*, spec. nov. Pages 46 to 47.

FIG. 2. Upper part of a compound sterile pinna.

FIG. 3. Portion of a fertile compound pinna with fully fructified pinnules.

FIG. 3 *a*. Pinnules of Fig. 3, magnified to show the sori.

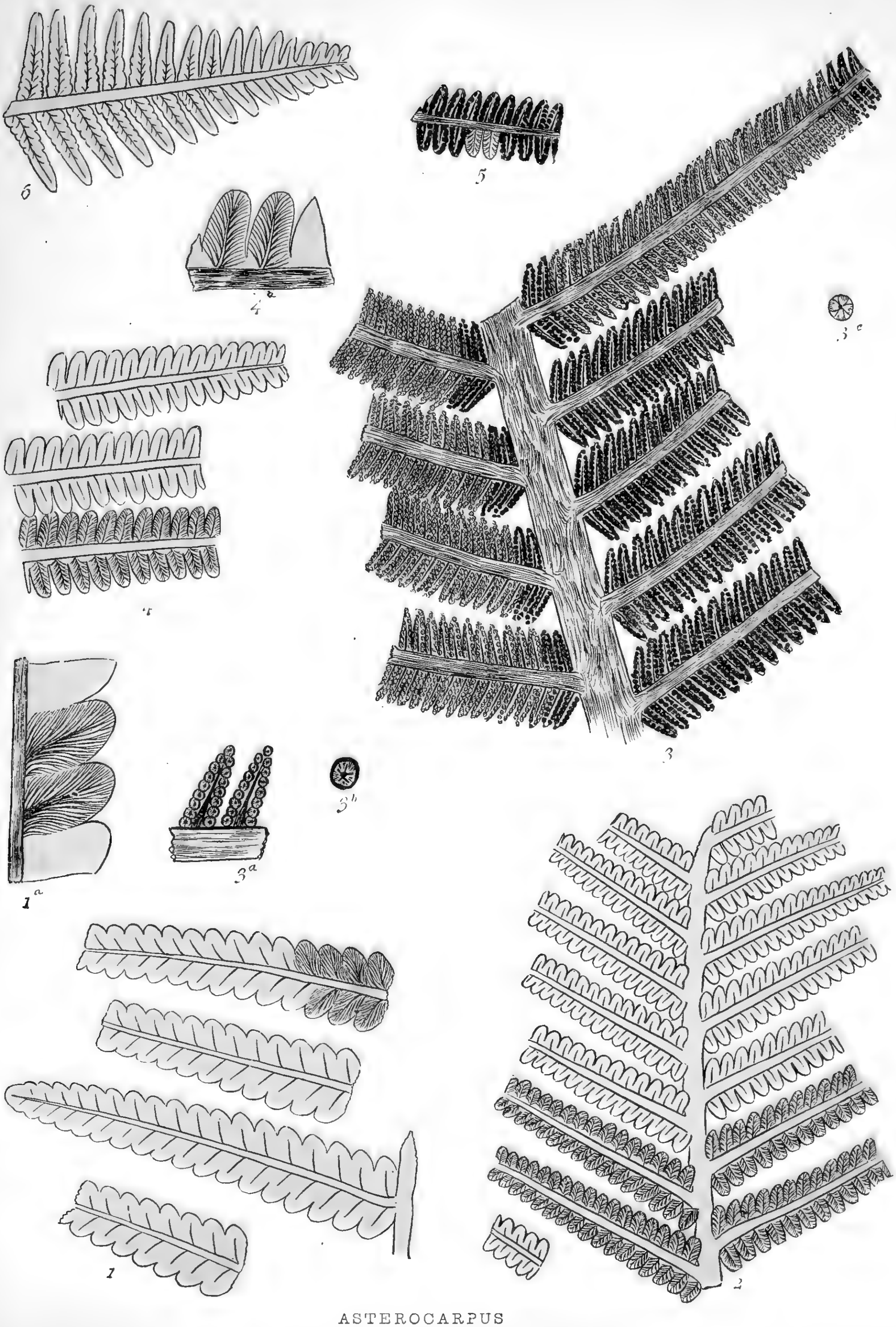
FIGS. 3 *b* and 3 *c*. Single sori of somewhat different form, much magnified.

FIG. 4. A portion of the lower part of a compound sterile pinna.

FIG. 4 *a*. Pinnules of Fig. 4, magnified to show the nervation.

FIG. 5. Fragment of pinna showing fertile and sterile pinnules on the same pinna.

FIG. 6. Summit of a sterile compound pinna.



ASTEROCARPUS

PLATE XXVI.

FIG. 1. *Asterocarpus platyrachis*, spec. nov. Pages 46 to 47. Upper part of a fertile compound pinna.

FIGS. 2, 2*a*. *Asterocarpus penticarpus*, spec. nov. Page 48.

FIG. 2. Portion of a fertile frond.

FIG. 2*a*. Pinnules of Fig. 2, magnified to show the sori.

FIGS. 3–4*a*. *Pecopteris rarinervis*, spec. nov. Pages 48 to 49.

FIG. 3. Portion of an ultimate pinna.

FIG. 3*a*. Pinnule of Fig. 3, magnified to show nervation.

FIG. 4 Summit of an ultimate pinna.

FIG. 4*a*. Pinnules of Fig 4, magnified to show nervation.

FIGS. 5, 5*a*. *Cladophlebis ovata*, spec. nov. Pages 50 to 51.

FIG. 5. Normal form of the plant.

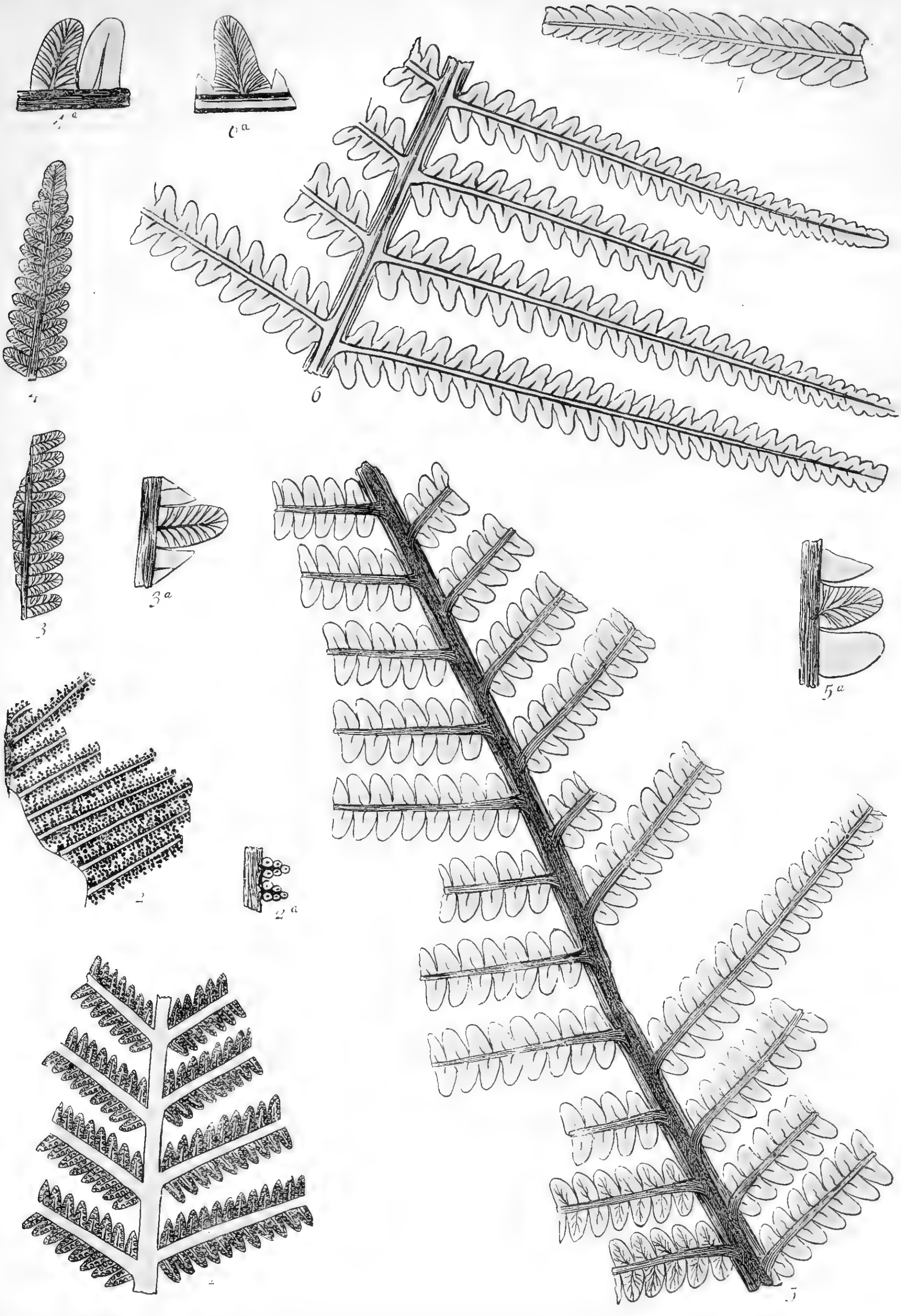
FIG. 5*a*. Pinnules of Fig. 5, magnified to show nervation.

FIGS. 6–7. *Cladophlebis auriculata*, spec. nov. Page 50.

FIG. 6. Normal form of the plant.

FIG. 6*a*. Pinnule of Fig. 6, magnified to show nervation.

FIG. 7. Abnormal form of the pinnules.



ASTEROCARPUS—PECOPTERIS—CLADOPHLEBIS

PLATE XXVII.

FIGS. 1, 1*a*. *Cladophlebis rotundiloba*, spec. nov. Pages 52 to 53.

FIG. 1. Portion of pinna.

FIG. 1*a*. Pinnules of Fig. 1, magnified to show nervation.

FIGS. 2, 2*a*. *Cladophlebis microphylla*, spec. nov. Pages 51 to 52.

FIG. 2. Portion of the upper part of a compound pinna, or of the frond.

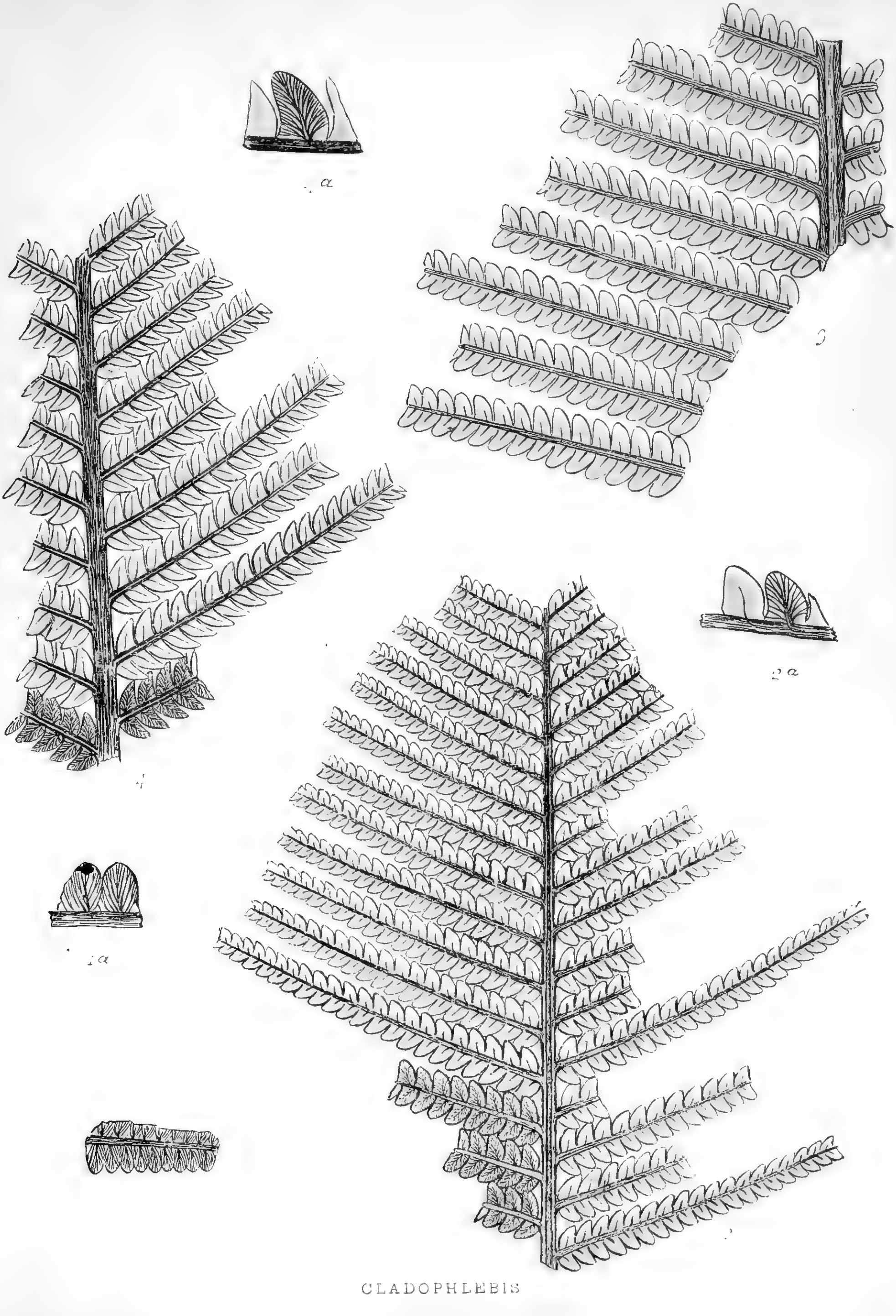
FIG. 2*a*. Pinnules of Fig. 2. magnified to show nervation.

FIG. 3. *Cladophlebis ovata*, spec. nov. Pages 50 to 51. Gives a portion of the lower part of a compound pinna, or of the frond.

FIGS. 4, 4*a*. *Cladophlebis pseudowhitbiensis*, spec. nov. Page 52.

FIG. 4. Portion of a compound pinna, or of the frond.

FIG. 4*a*. Pinnule of Fig. 4, magnified to show nervation.



CLADOPHLEBIS

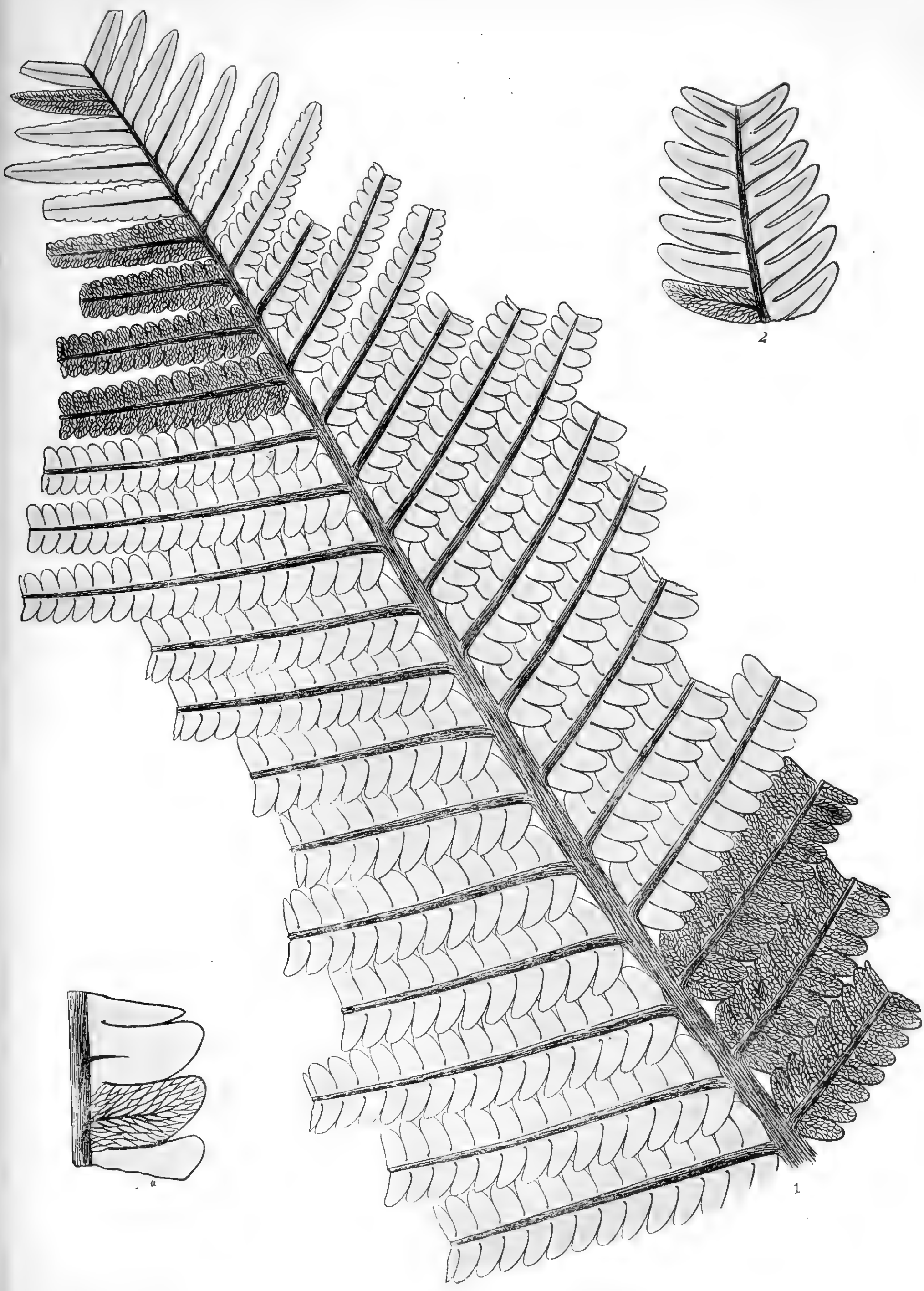
PLATE XXVIII.

FIGS. 1-2. *Lonchopteris Virginiensis*, spec. nov. Pages 53 to 54.

FIG. 1. Summit of a large compound pinna, or of the frond.

FIG. 1*a*. Pinnules of Fig. 1, magnified to show nervation.

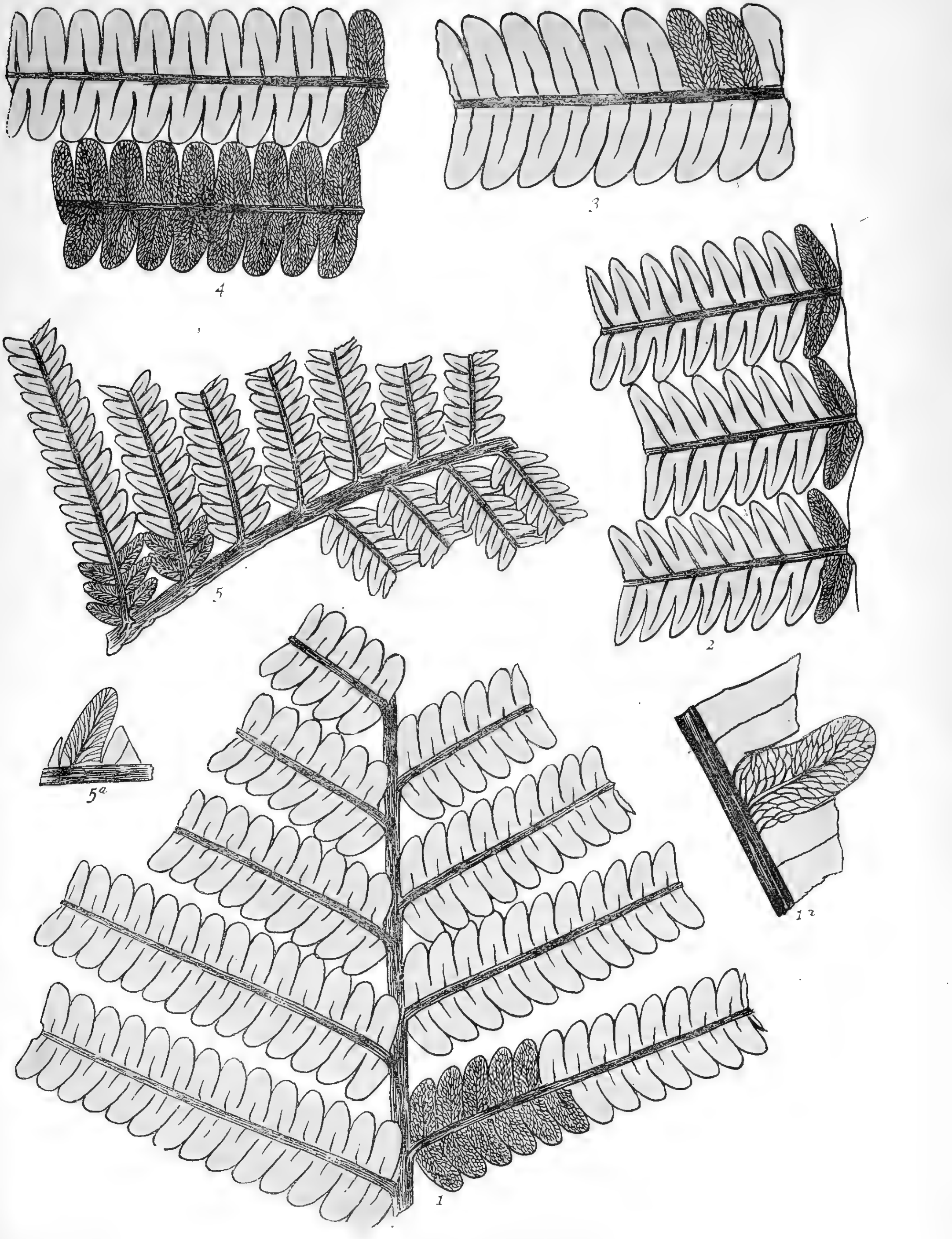
FIG. 2. Portion of a pinna with long acute pinnules.



LONCHOPTERIS VIRGINIENSIS

PLATE XXIX.

FIGS. 1–4. *Lonchopteris Virginiensis*, spec. nov. Pages 53 to 54.
FIG. 1. Portion of frond with normal, rounded pinnules.
FIG. 1*a*. Pinnule of Fig. 1, magnified to show nervation.
FIG. 2. Portions of pinnæ, with normal acute pinnules.
FIG. 3. Portion of a pinna with pinnules of the largest size.
FIG. 4. Portions of pinnæ showing broad rounded pinnules.
FIGS. 5, 5*a*. *Cladophlebis subfalcata*, spec. nov. Page 49.
FIG. 5. Shows the normal character.
FIG. 5*a*. Pinnule of Fig. 5, magnified to show nervation.



LONCHOPTERIS-CLADOPHLEBIS

PLATE XXX.

FIGS. 1–4 *a*. *Pseudodanæopsis reticulata*, spec. nov. Pages 59 to 60.

FIG. 1. Portion of the frond restored, showing pinnules of large size.

FIG. 2. Fragment of a very large pinnule.

FIG. 2 *a*. Portion of Fig. 2, magnified to show nervation.

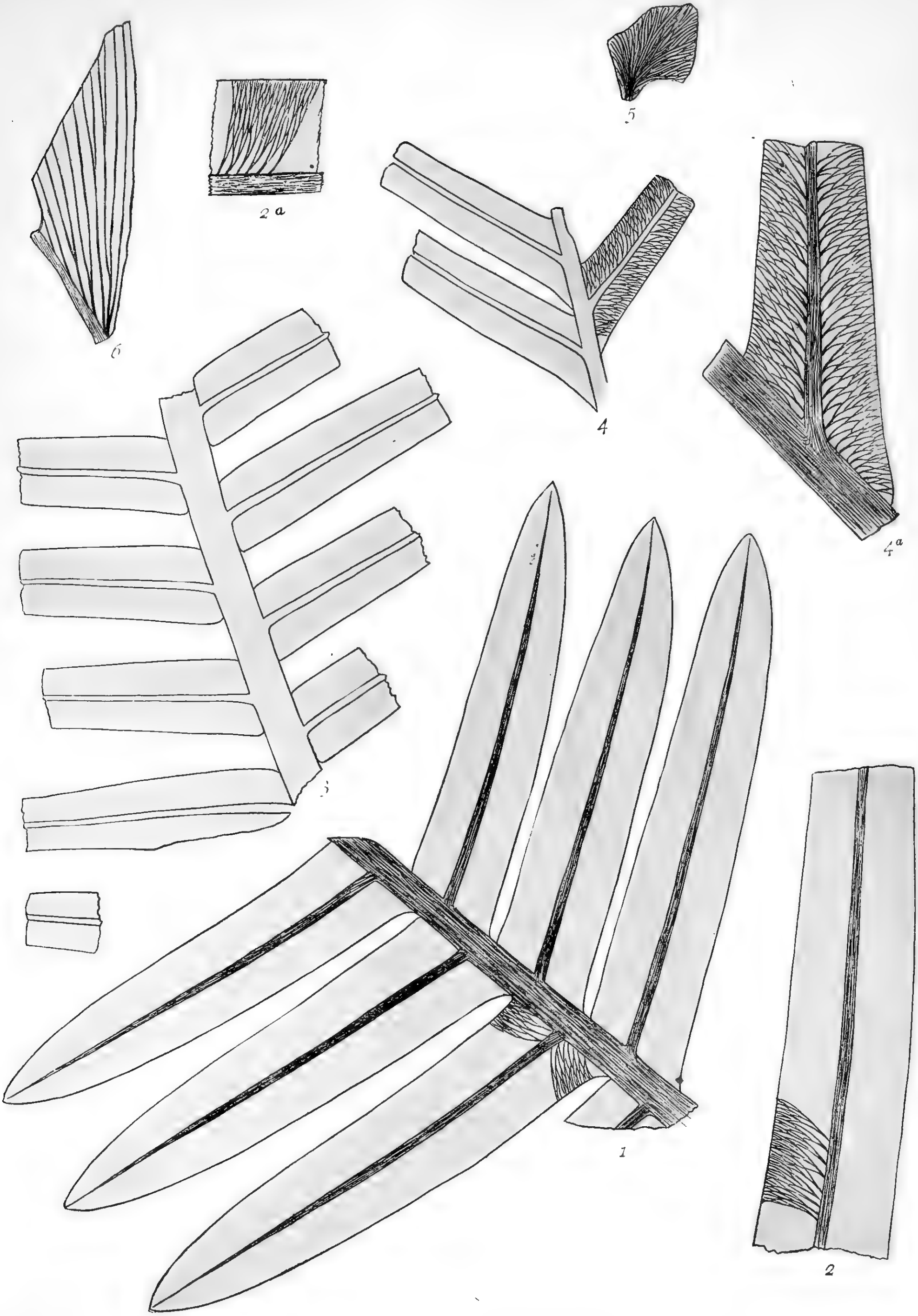
FIG. 3. Portion of a frond with pinnules of the smaller kind.

FIG. 4. Upper part of a compound pinna with small pinnules.

FIG. 4 *a*. Portion of a pinnule of Fig 4, much magnified to show nervation.

FIG. 5. *Sagenopteris rhoifolia*, Pr. Page 63. Fragment of a leaflet.

FIG. 6. *Dicranopteris*, Spec. (?). Page 63. Gives a fragment of a leaf like Dicranopteris.



PSEUDODANÆOPSIS-SAGENOPTERIS-DICRANOPHYLLUM

PLATE XXXI.

FIGS. 1, 2. *Pseudodanæopsis nervosa*, spec. nov. Pages 61 to 63.

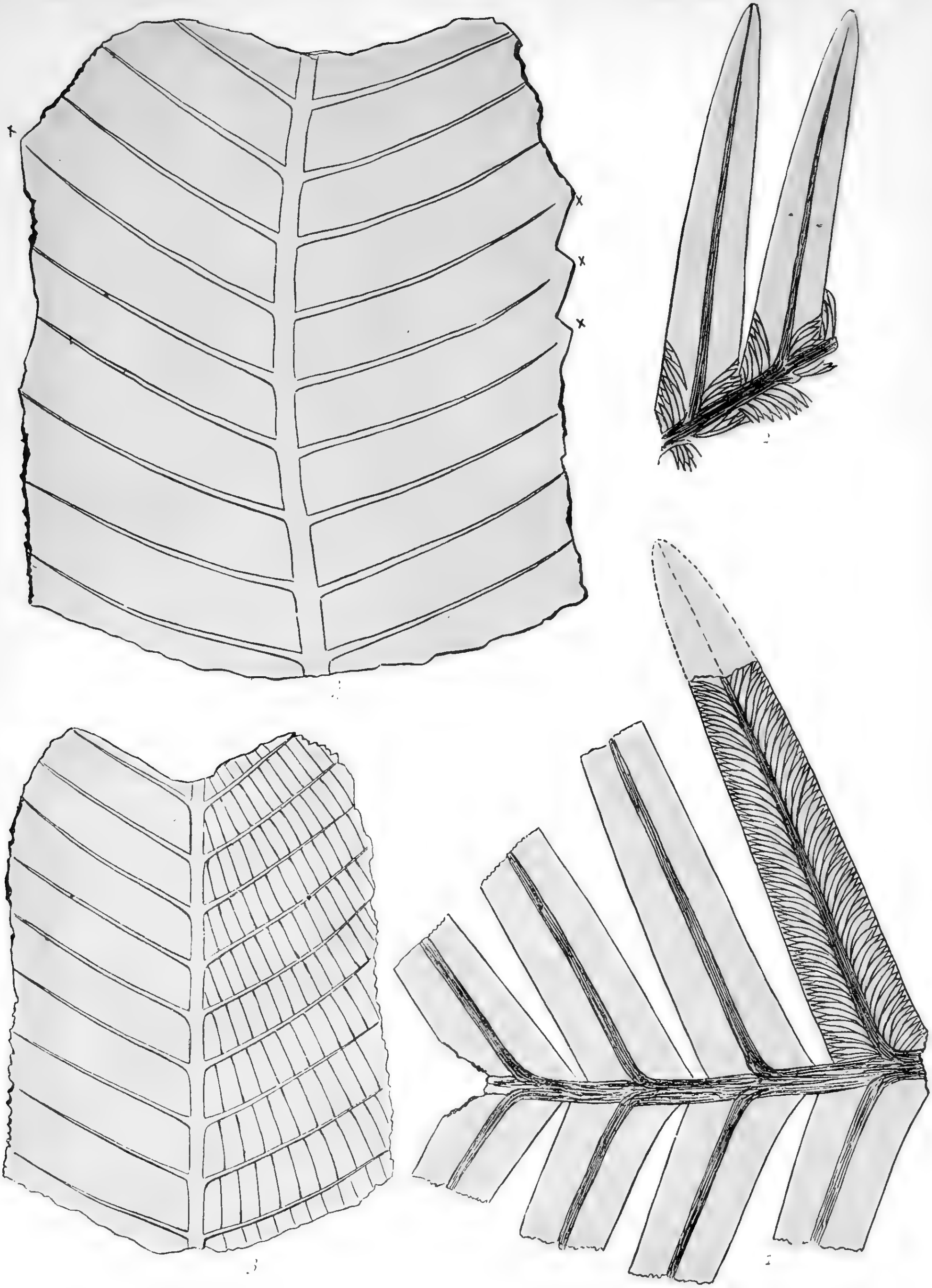
FIG. 1. Portion of the plant showing pinnules of normal size.

FIG. 2. Portion of the upper part of the plant.

FIGS. 3, 4. *Clathropteris platyphylla*, var. *expansa*, Sap. Pages 54 to 58.

FIG. 3. Portion of a small segment showing only the cross-bars of the nervation.

FIG. 4. Portion of a segment of normal size showing three teeth on the right-hand border and one on the left-hand border.



PSEUDODANÆOPSIS-CLATHROPTERIS

PLATE XXXII.

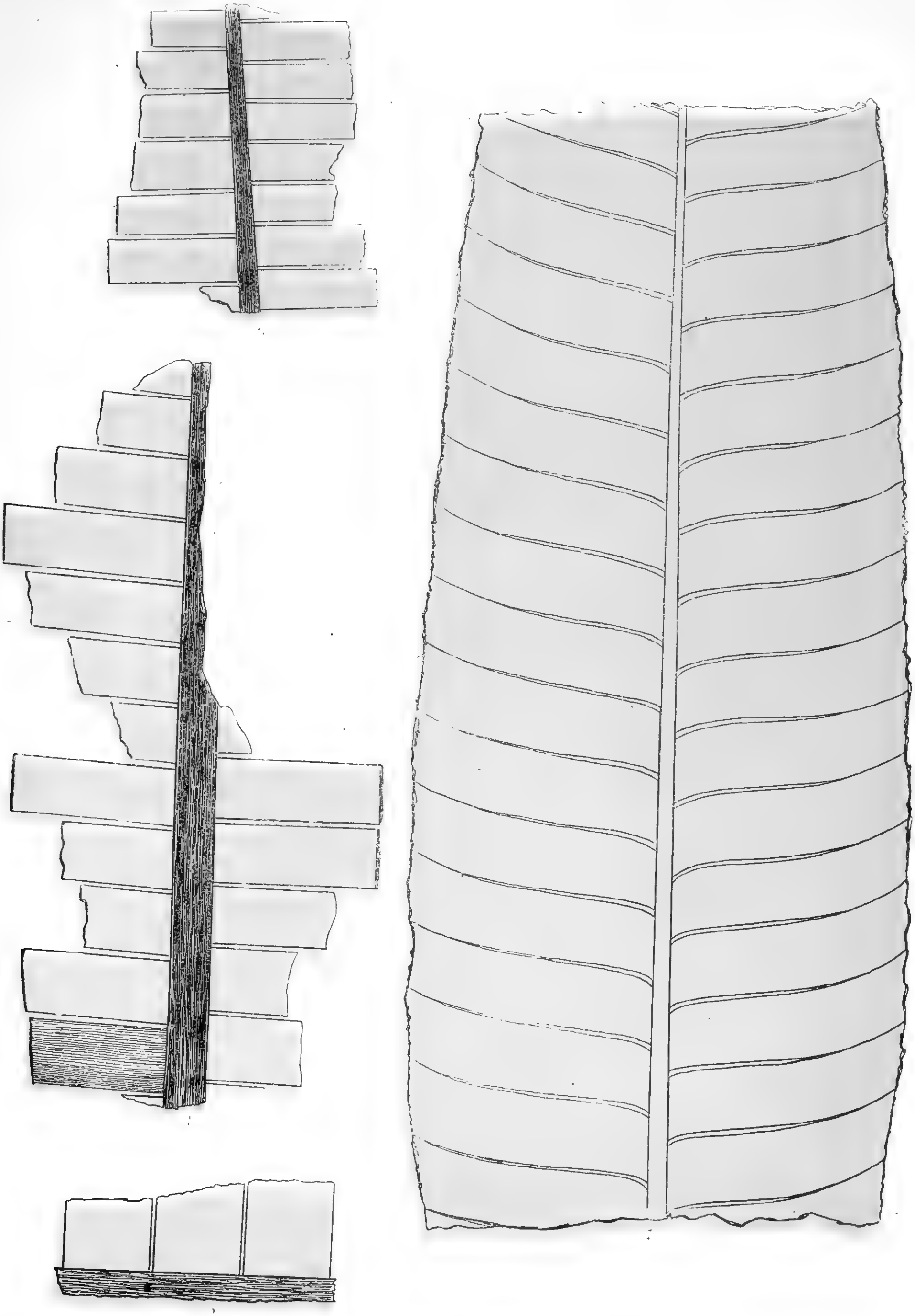
FIG. 1. *Clathropteris platyphylla*, var. *expansa*, Sap. Pages 54 to 58. Represents a segment with incomplete margins, but quite long.

FIGS. 2–4. *Pterophyllum affine*, Nathorst. Pages 66 to 67.

FIG. 2. Fragment with the broadest leaflets.

FIG. 3. Fragment of leaf with average-sized leaflets.

FIG. 4. Fragment with leaflets of the narrowest kind.



CLATHROPTERIS PLATYPHYLLA

PLATE XXXIII.

FIG. 1. *Clathropteris platyphylla*, var. *expansa*, Sap. Pages 54 to 58. Shows the basal undivided part of the frond.

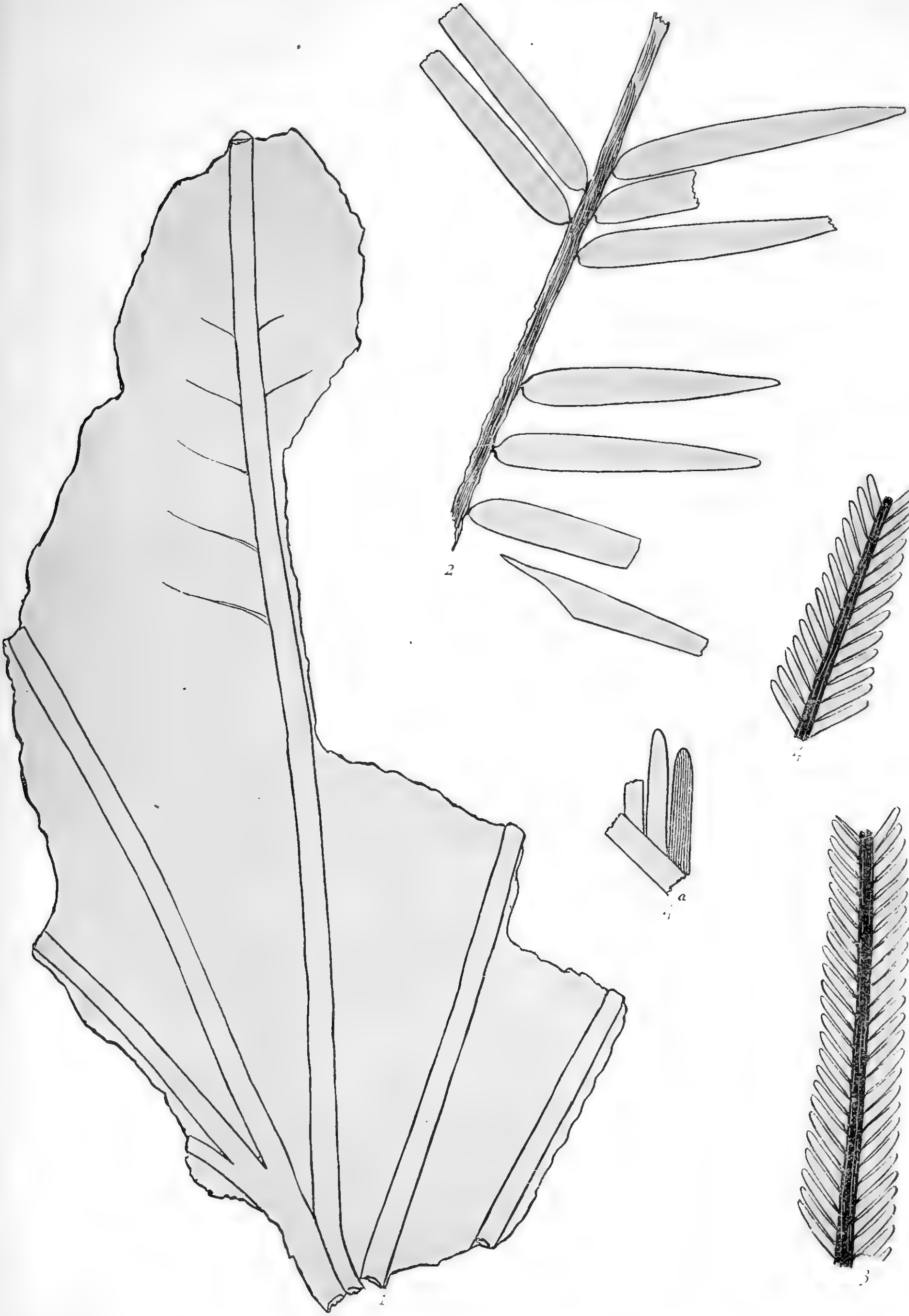
FIG. 2. *Podozamites Emmonsi* (*P. lanceolatus* of Emmons). Pages 77 to 78. Gives a form with leaflets rather narrower than the normal form given by Emmons.

FIGS. 3–4 *a*. *Ctenophyllum taxinum*, Lind. and Hut. Pages 67 to 68.

FIG. 3. Lower portion of a leaf.

FIG. 4. Upper portion of a leaf.

FIG. 4 *a*. Leaflet of Fig. 4, magnified to show nervation.



CLATHROPTERIS-PODOZAMITES-CTENOPHYLLUM

PLATE XXXIV.

FIG. 1. *Clathropteris platyphylla*, var. *expansa*, Sap. Pages 54 to 58. Portion of the undivided part of a large frond.

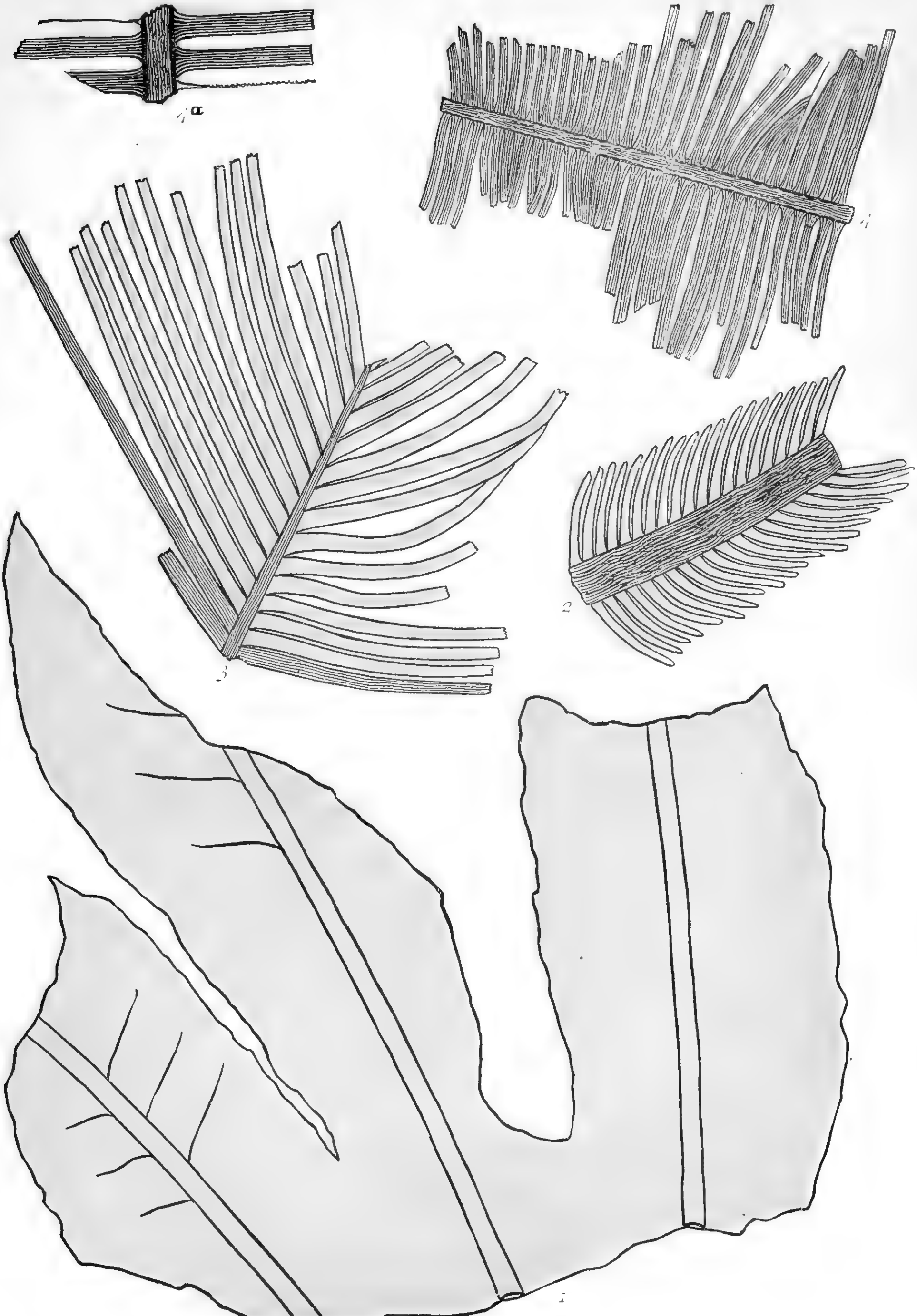
FIGS. 2–4*a*. *Ctenophyllum Braunianum*, Goepp. Pages 69 to 73.

FIG. 2. Fragment of the lowest part of a leaf next to the leafless petiole.

FIG. 3. Fragment from the upper part of a leaf.

FIG. 4. Fragment from the middle part of a leaf.

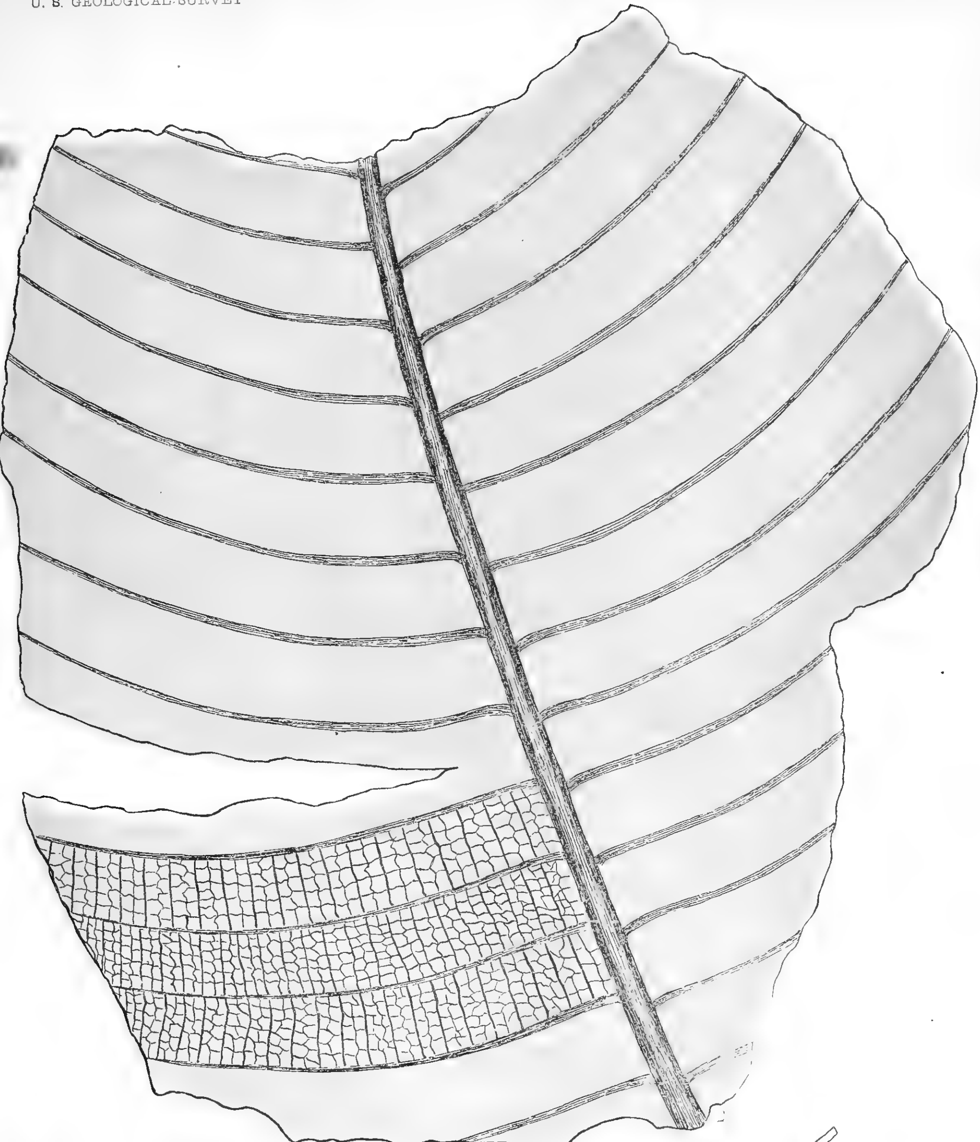
FIG. 4*a*. Portion of Fig. 4, magnified to show nervation.

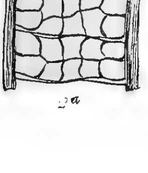


CLATHROPTERIS. CTENOPHYLLUM

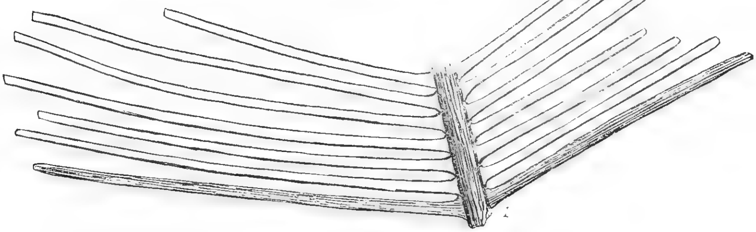
PLATE XXXV.

Fig. 1. *Ctenophyllum Braunianum,* Goepp. Pages 69 to 73. Fragment of the upper part of a large leaf.
Figs. 2, 2 a. *Clathropteris platyphylla,* var. *expansa,* Sap. Pages 54 to 58.
  Fig. 2. Fragment of a very large segment.
  Fig. 2 a. Portion of Fig. 2, magnified to show nervation.





2a



CTENOPHYLLUM-CLATHROPTERIS

PLATE XXXVI.

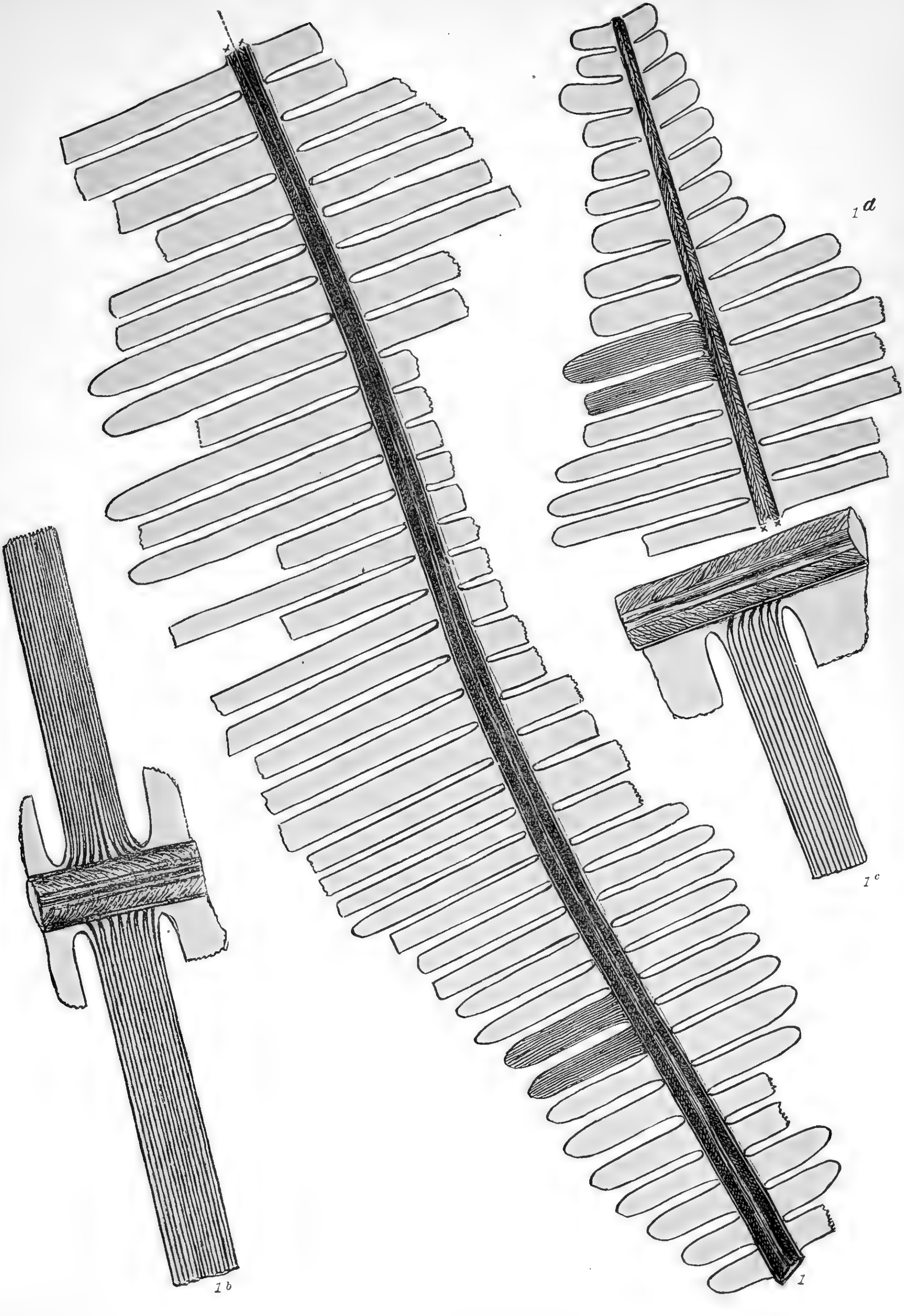
FIGS. 1, 1*a*, 1*b*, 1*c*. *Pterophyllum inæquale*, spec. nov. Pages 64 to 65.

FIG. 1. Leaf of normal kind.

FIG. 1*a*. Summit of Fig. 1.

FIG. 1*b*. Portion of a leaflet from the lower part of Fig. 1, magnified to show nervation.

FIG. 1*c*. Portion of a leaflet from Fig. 1*a*, magnified to show nervation.



PTEROPHYLLUM INÆQUALE

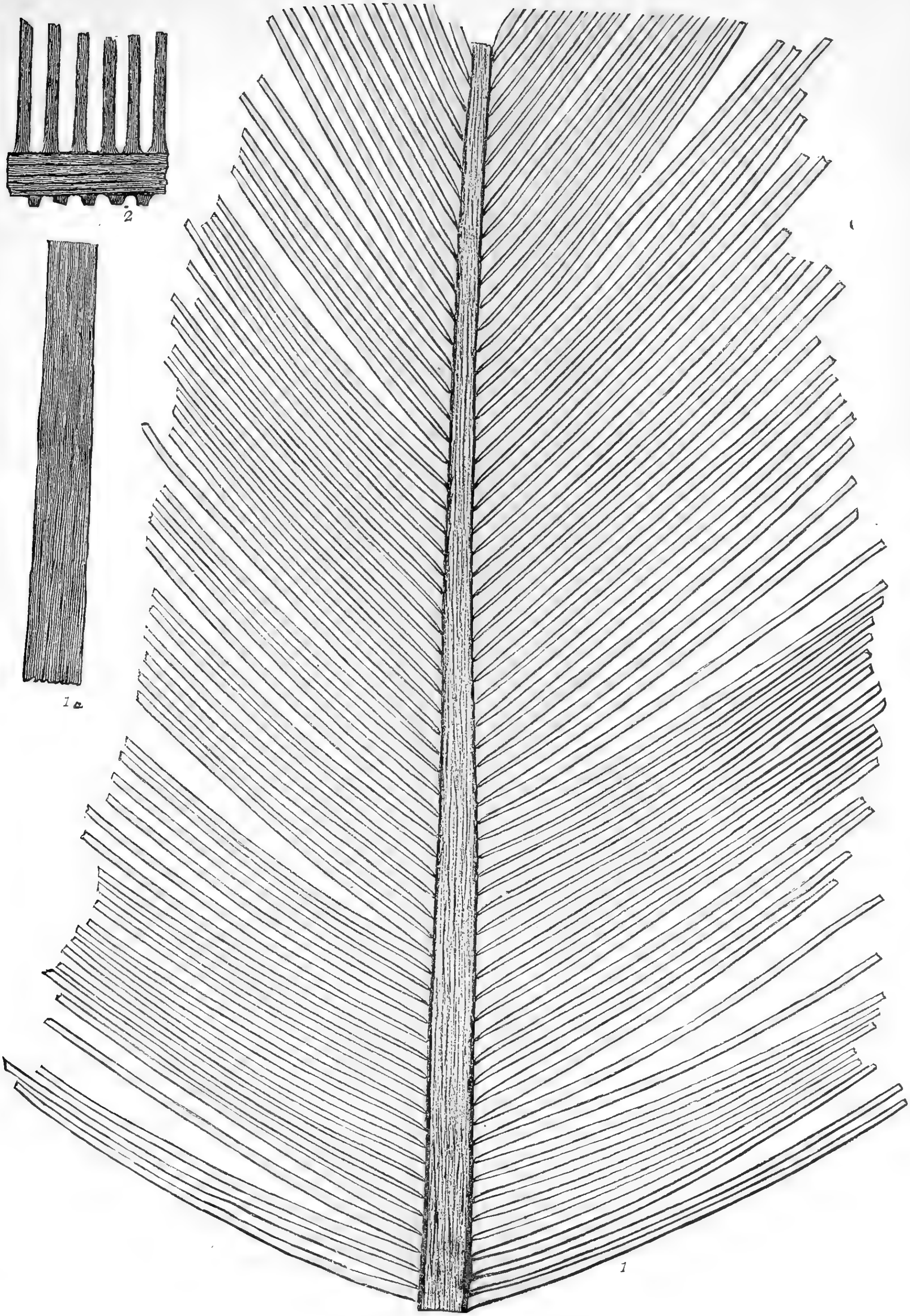
PLATE XXXVII.

FIGS. 1–2. *Ctenophyllum Braunianum*, Goepp. Pages 69 to 73.

FIG. 1. Upper portion of a large leaf.

FIG. 1*a*. Portion of the petiole of Fig. 1.

FIG. 2. Fragment of a middle portion of a leaf, showing leaflets unusually distant.



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1a

1

CTENOPHYLLUM BROUNIANUM

PLATE XXXVIII.

FIGS. 1–2 *a*. *Ctenophyllum Braunianum*, Goepp. Pages 69 to 73.

FIG. 1. Summit of the large leaf given in Fig. 1, Plate XXXVII.

FIG. 2. Upper portion of a leaf, showing the rounded form of the midrib on the under side.

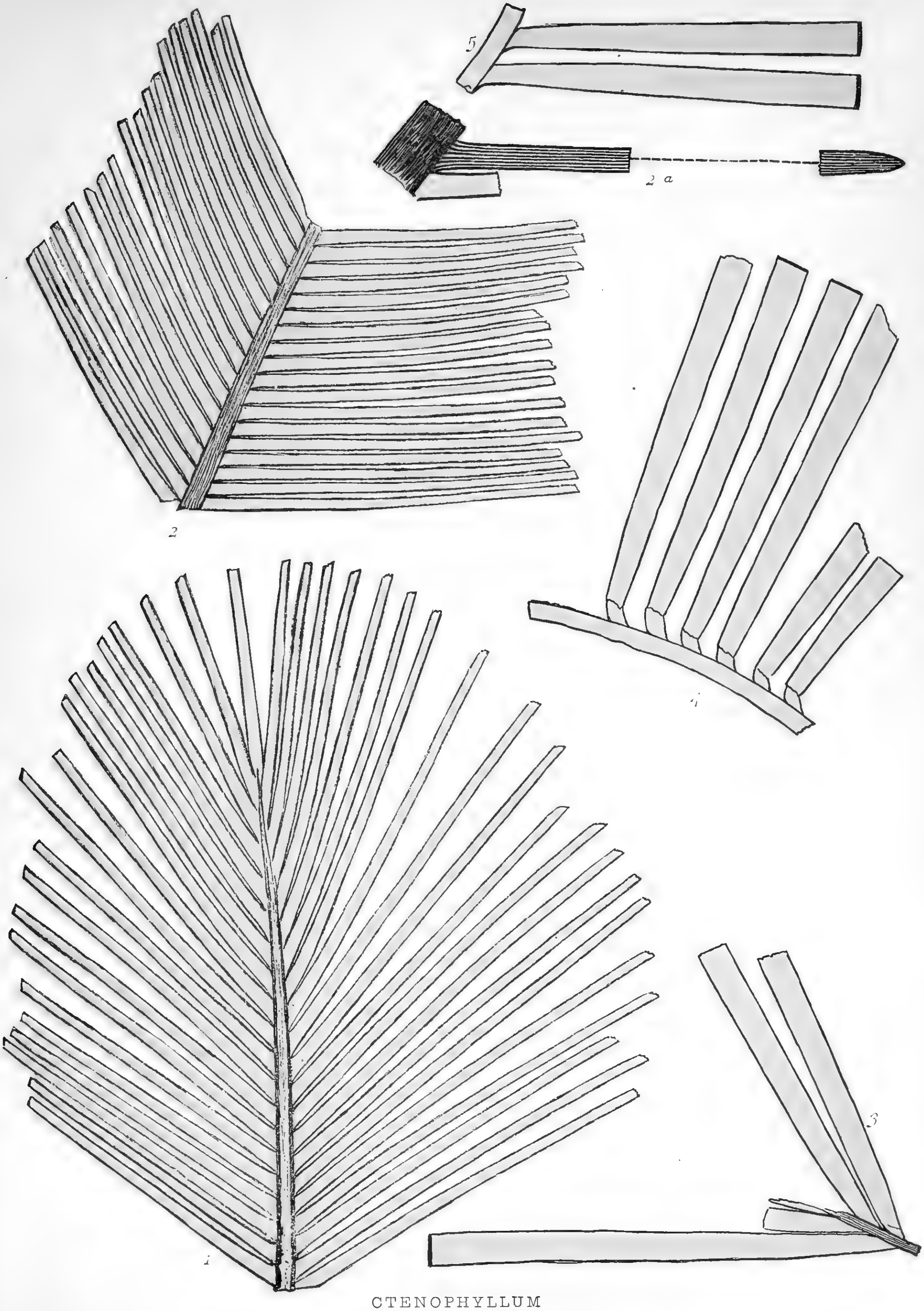
FIG. 2 *a*. Base and summit of a leaflet of Fig. 2, magnified to show nervation.

FIGS. 3–5. *Ctenophyllum truncatum*, spec. nov. Pages 68 to 69.

FIG. 3. Upper portion of a leaf.

FIG. 4. Portion of a leaf, with the leaflets all broken at base.

FIG. 5. Shows natural position of leaflets in Fig. 4.



CTENOPHYLLUM

PLATE XXXIX.

FIGS. 1–3 *a*. *Ctenophyllum grandifolium*, spec. nov. Pages 73 to 76.

FIG. 1. Fragment of the lower part of the leaf, showing the great width of the flat stem.

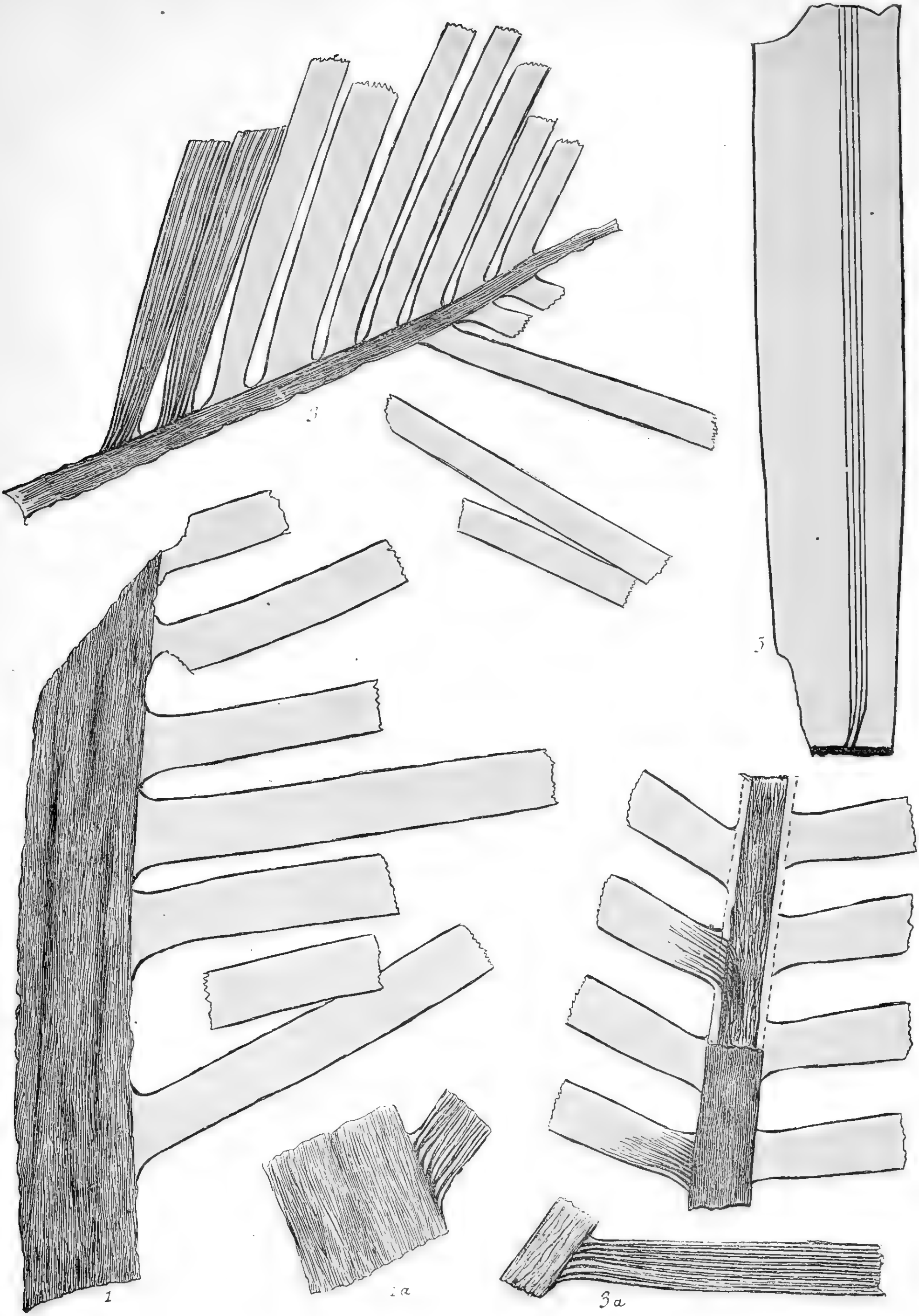
FIG. 1 *a*. Portion of Fig. 1, magnified to show the insertion of the nerves.

FIG. 2. Portion of the middle of a leaf with remote leaflets; also showing the thick epidermis of the stem and the effect of it in increasing the apparent width of the stem.

FIG. 3. Fragment of the upper part of a leaf.

FIG. 3 *a*. Portion of a leaflet of Fig, 3, magnified to show nervation.

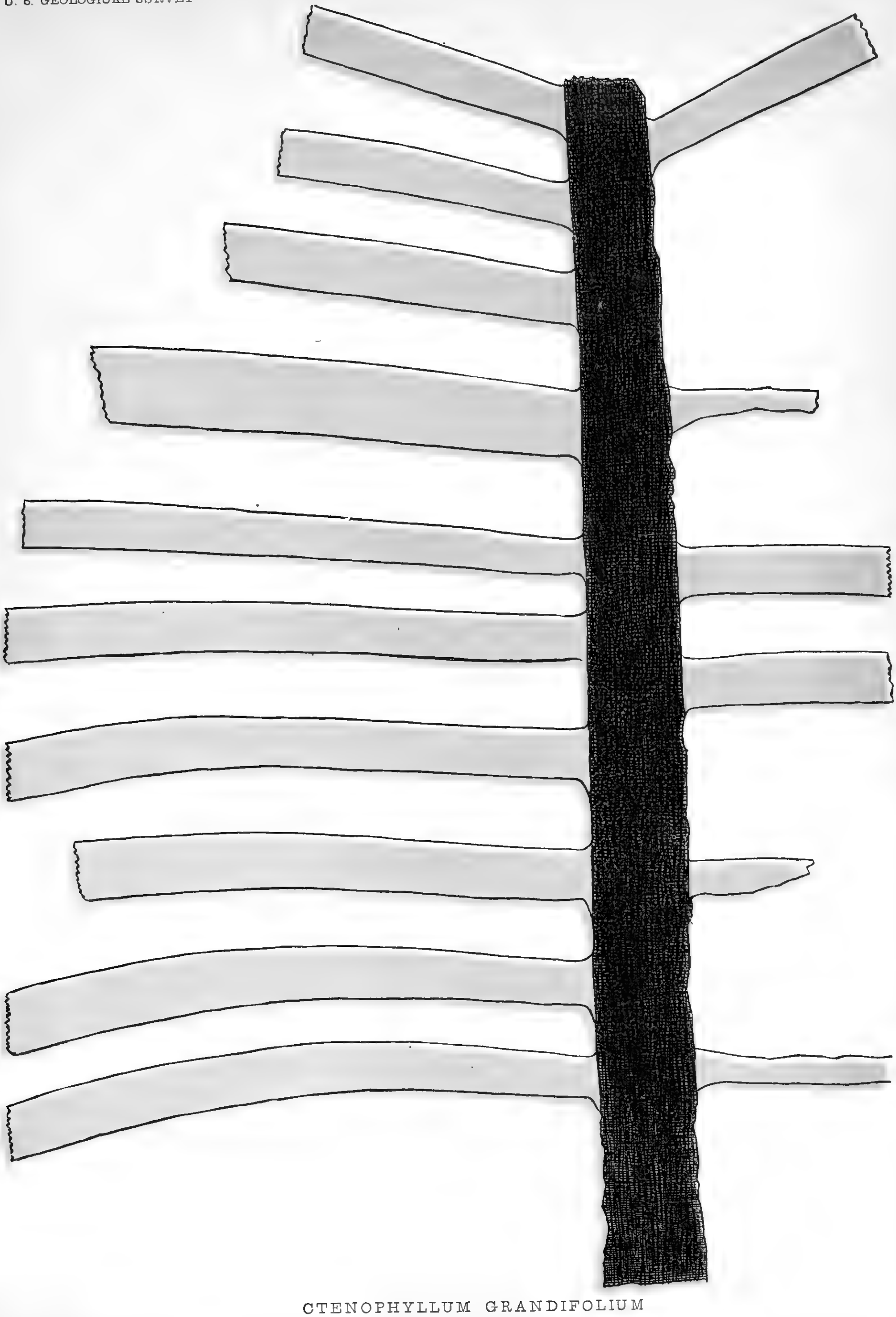
FIG. 5. *Ctenophyllum giganteum*, spec. nov. Pages 76 to 77. Shows a portion of a leaflet of a huge Ctenophyllum. The basal portion of the leaflet is that given here.



CTENOPHYLLUM

PLATE XL.

Ctenophyllum grandifolium, spec. nov. Pages 73 to 76. Represents the lower portion of a very large leaf of this plant. The leaflets extend to 12 and 18 inches in width.



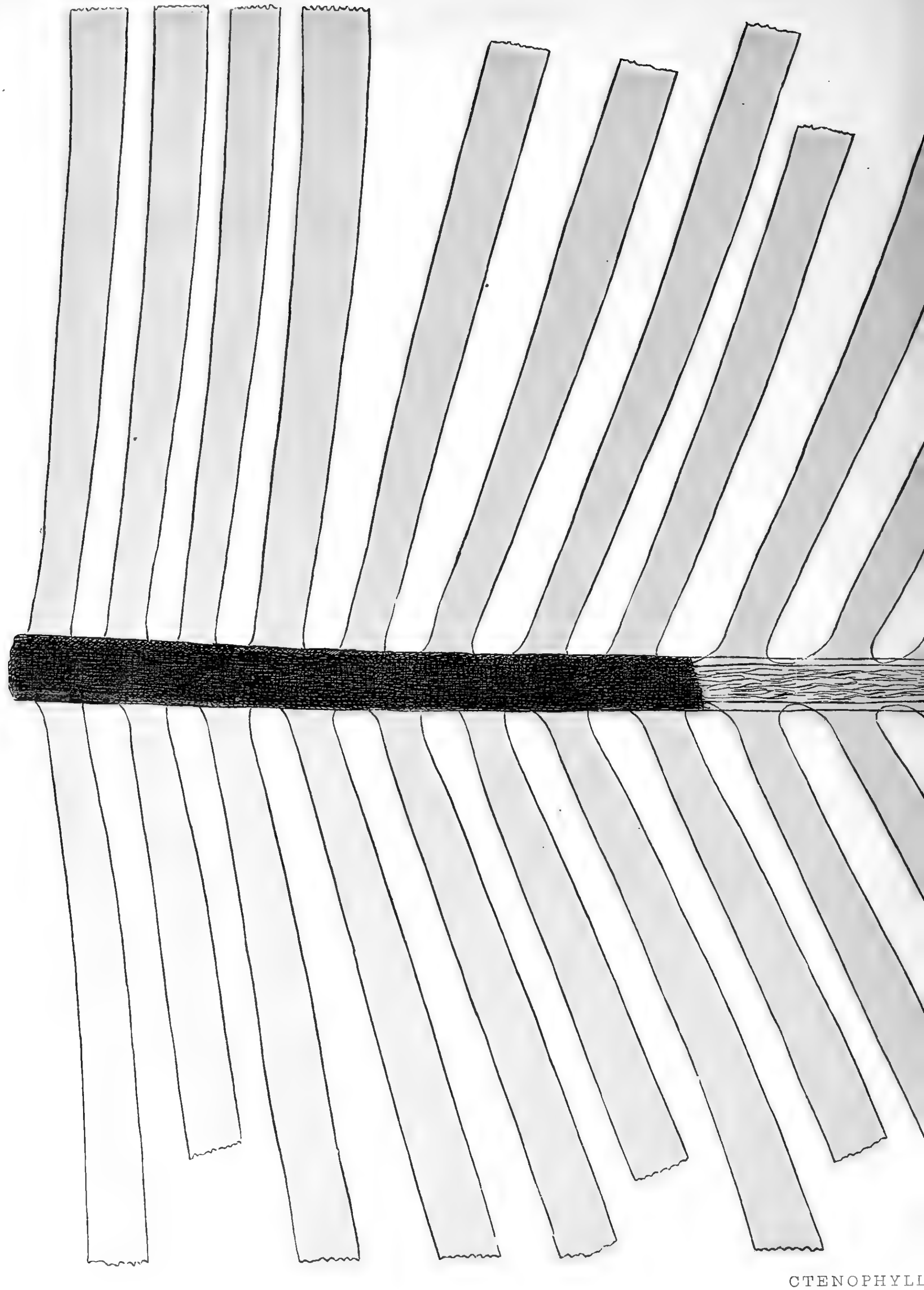
CTENOPHYLLUM GRANDIFOLIUM

PLATE XLI (double).

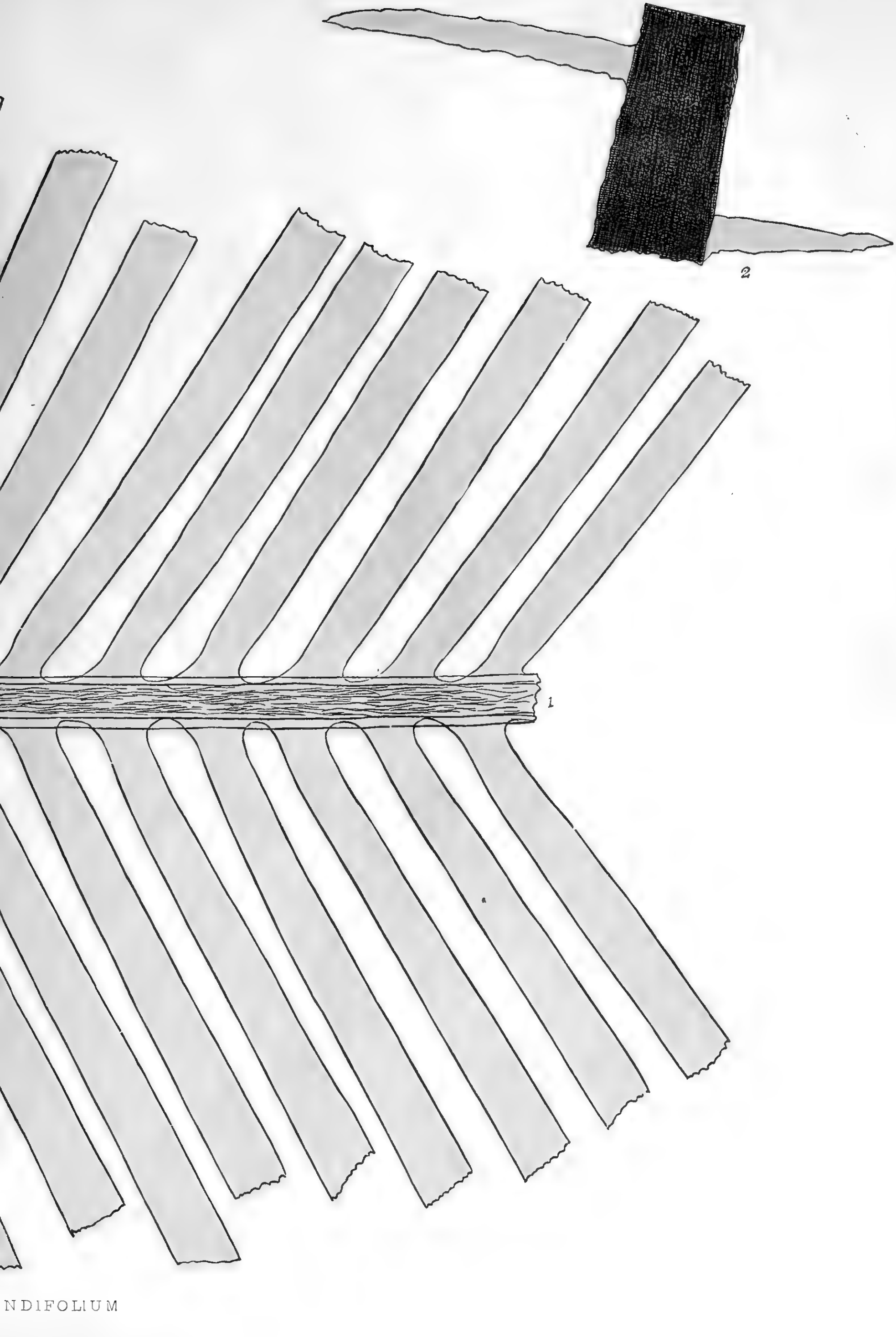
FIGS. 1, 2. *Ctenophyllum grandifolium*, spec. nov. Pages 73 to 76.

FIG. 1. Represents the middle portion of the same leaf whose base was given on Plate XL.

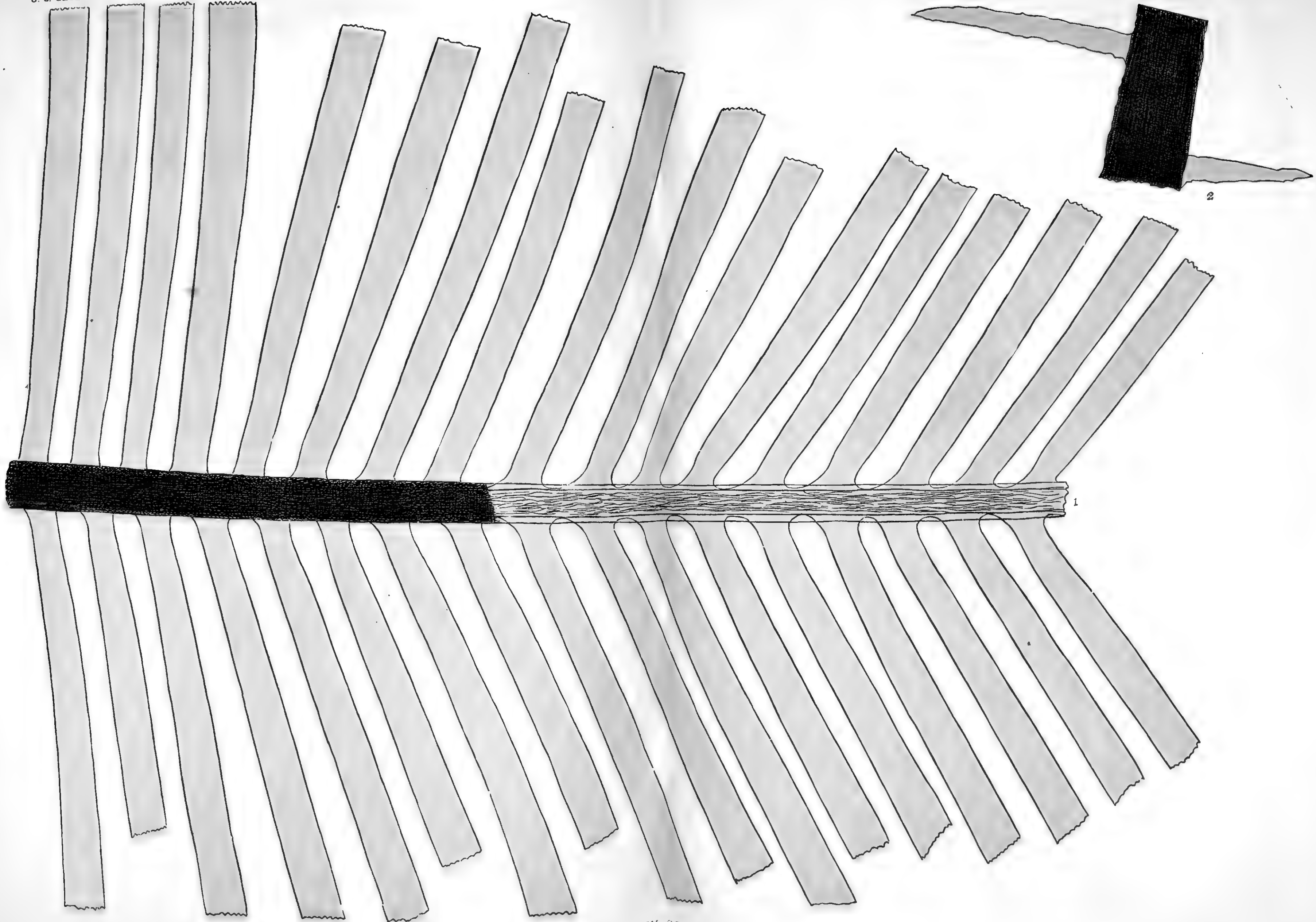
FIG. 2. Lower portion of the plant given on Plate XL



CTENOPHYLL



NDIFOLIUM



2

1

CTENOPHYLLUM GRANDIFOLIUM

PLATE XLII (double).

FIG. 1, 1 *a*, 1 *b*. *Ctenophyllum grandifolium*, spec. nov. Pages 73 to 76.

FIG. 1. Represents the summit of the same large leaf whose base is given on Plate XL, and middle portion in Fig. 1, Plate XLI.

FIG. 1 *a*. Represents the middle portion of a leaflet of Fig. 1, magnified to show the parallel position of the nerve-bundles.

FIG. 1 *b*. Represents a portion of the base of a leaflet of Fig. 1, still more magnified, to show the complex nature and mode of splitting up of the nerve-bundles at their base.

FIGS. 2–5. *Podozamites tenuistriatus*, spec. nov. Pages 78 to 79.

FIG. 2. Gives a fragment of a leaf of the largest form.

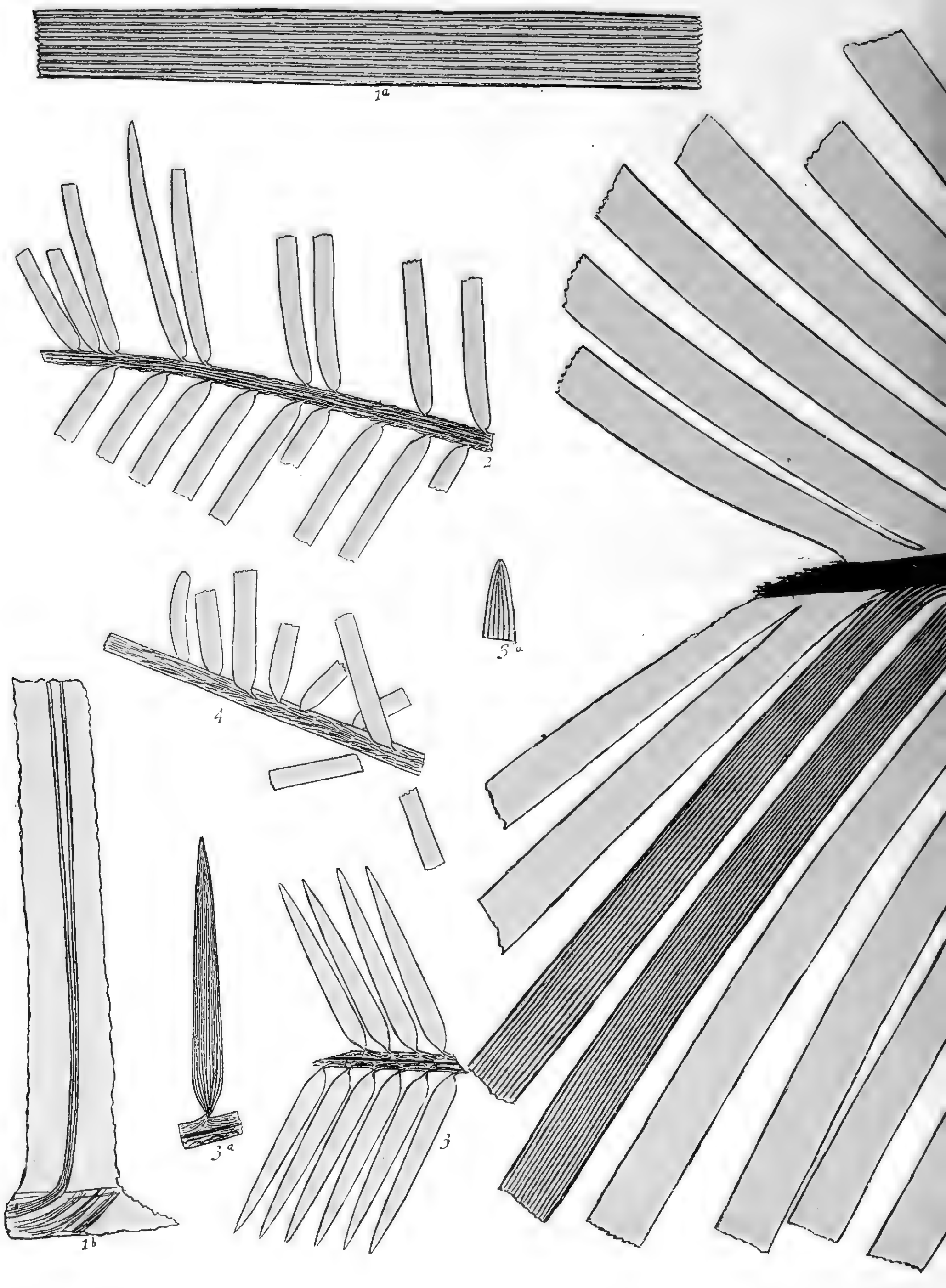
FIG. 3. Gives a portion of a leaf of normal size.

FIG. 3 *a*. Leaflet of Fig. 3, magnified to show nervation.

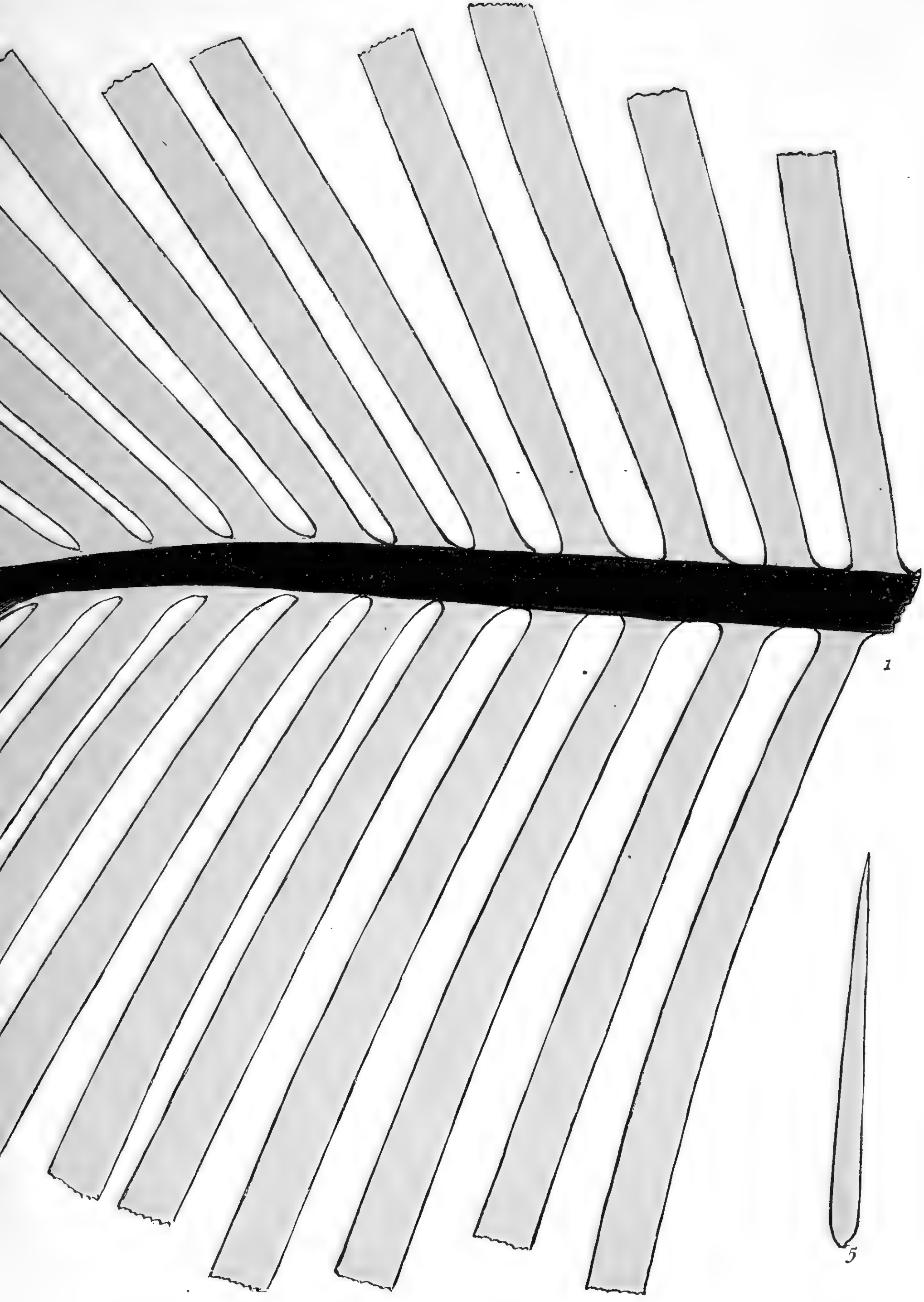
FIG. 3 *b*. Tip of Fig. 3 *a*, still more magnified to show convergence of the nerves at their ends.

FIG. 4. Fragment of a plant showing insertions of leaflets perhaps flattened from above.

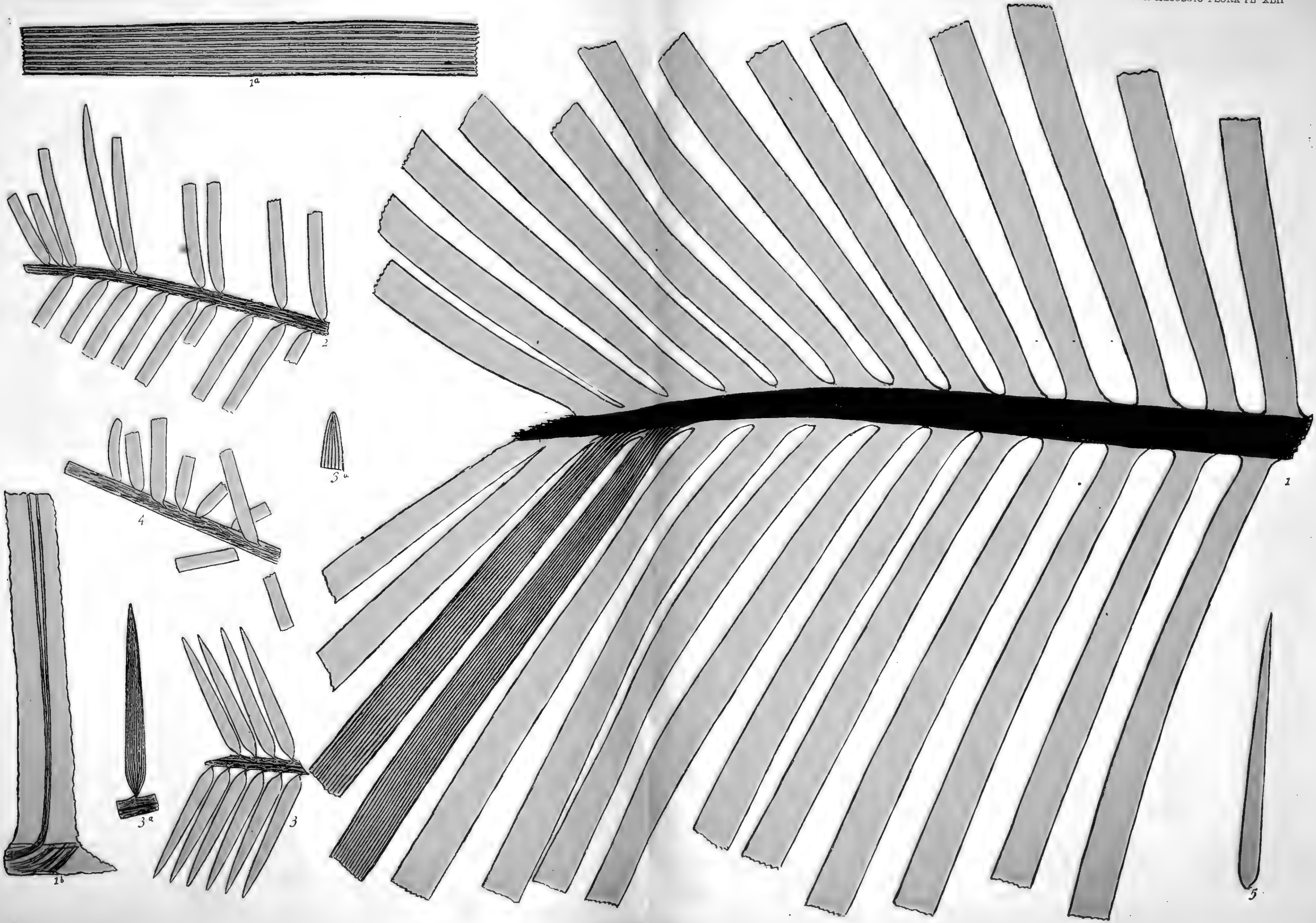
FIG. 5. Leaflet of largest size.



CTENOPHYLLU



PODOZAMITES



CTENOPHYLLUM—PODOZAMITES

PLATE XLIII.

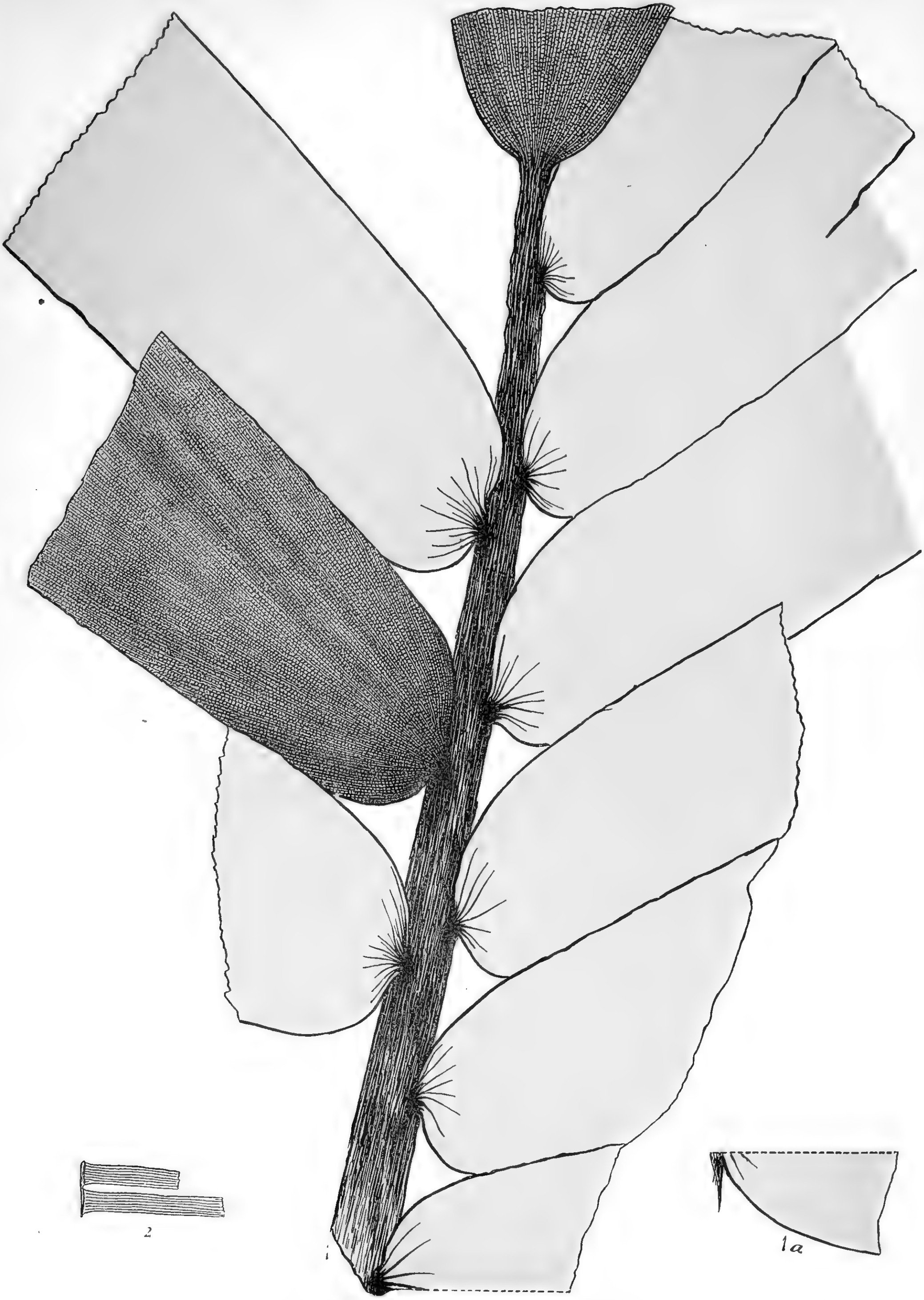
FIG. 1, 1 *a*. *Sphenozamites Rogersianus*, spec. nov. Pages 80 to 84.

FIG. 1. Summit of a leaf of medium size.

FIG. 1 *a*. Belongs to the lowest leaflet on the right-hand side.

FIG. 2. *Pterophyllum decussatum*, Emmons. Page 67.

FIG. 2. Gives the insertion and basal Plate XLIV portions of two leaflets.



SPHENOZAMITES—PTEROPHYLLUM

PLATE XLIV.

Figs. 1–2 *b*. *Sphenozamites Rogersianus*, spec. nov. Pages 80 to 84.

Fig. 1. Portion of the middle part of a leaf of normal size.

Fig. 2. Nervation magnified to show the granulation.

Fig. 2 *a*. Nervation magnified to show the complexity of the nerves and their mode of forking from the base.

Fig. 2 *b*. Nervation still more magnified to show the elongation of the dots into cross-bars.

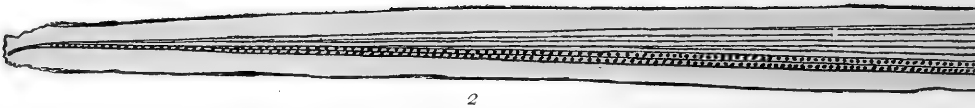
Fig. 3. *Podozamites tenuistriatus*, spec. nov. Pages 78 to 79. Shows a form with leaflets broad near the insertions.

Figs. 4–6. *Cycadites tenuinervis*, spec. nov. Page 84.

Fig. 4. Represents the upper part of a leaf.

Fig. 5. Represents the middle part of a leaf.

Fig. 6. Represents a small form.



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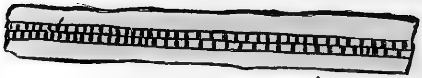
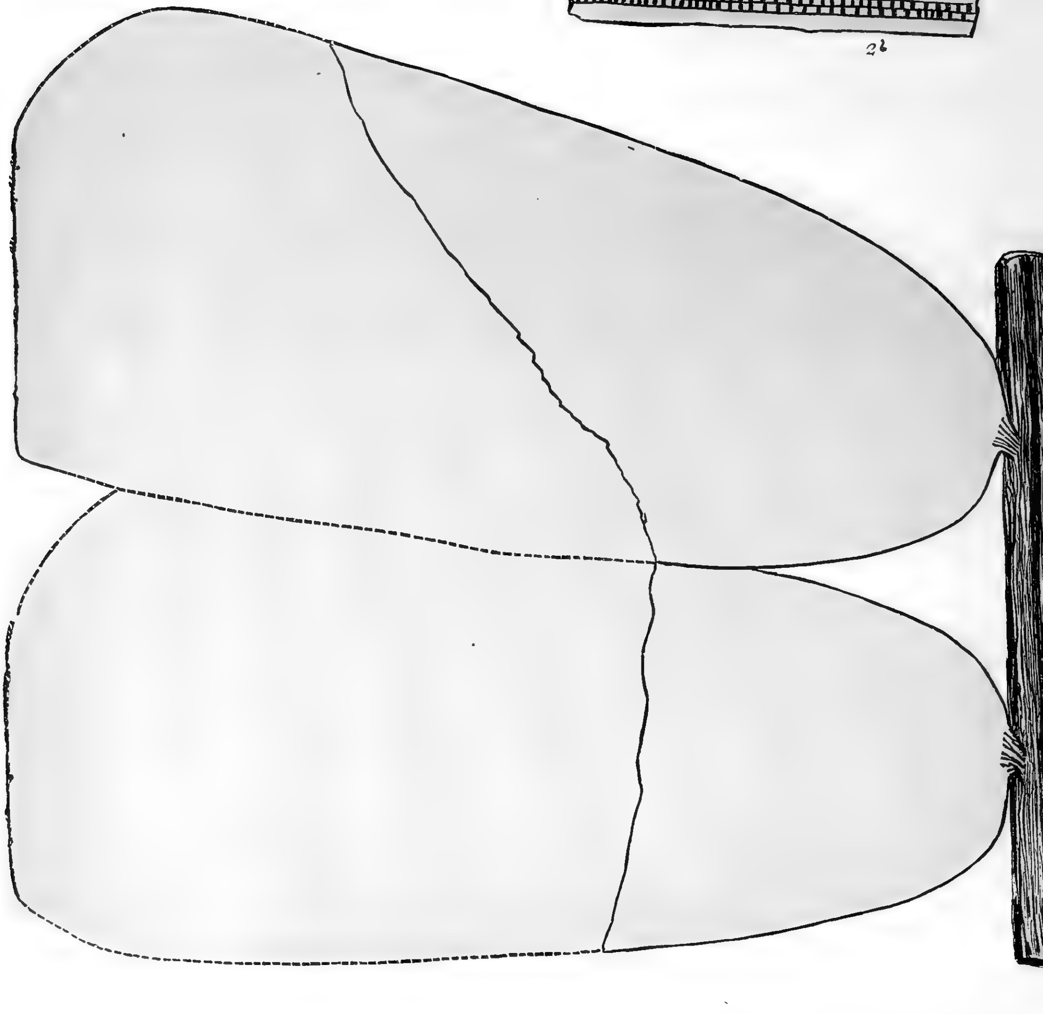
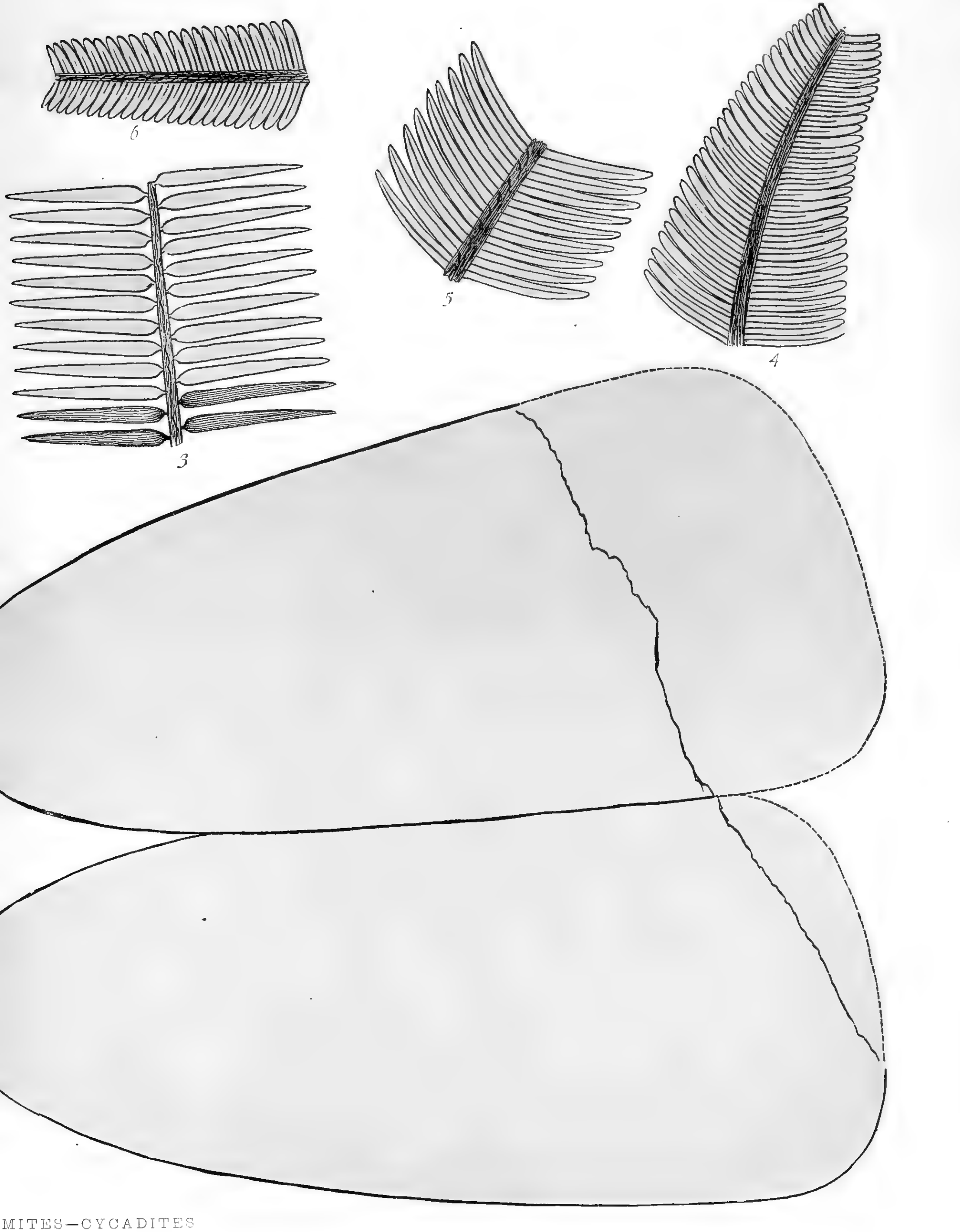
2a



2b



SPHENOZAMITES—P



MITES—CYCADITES

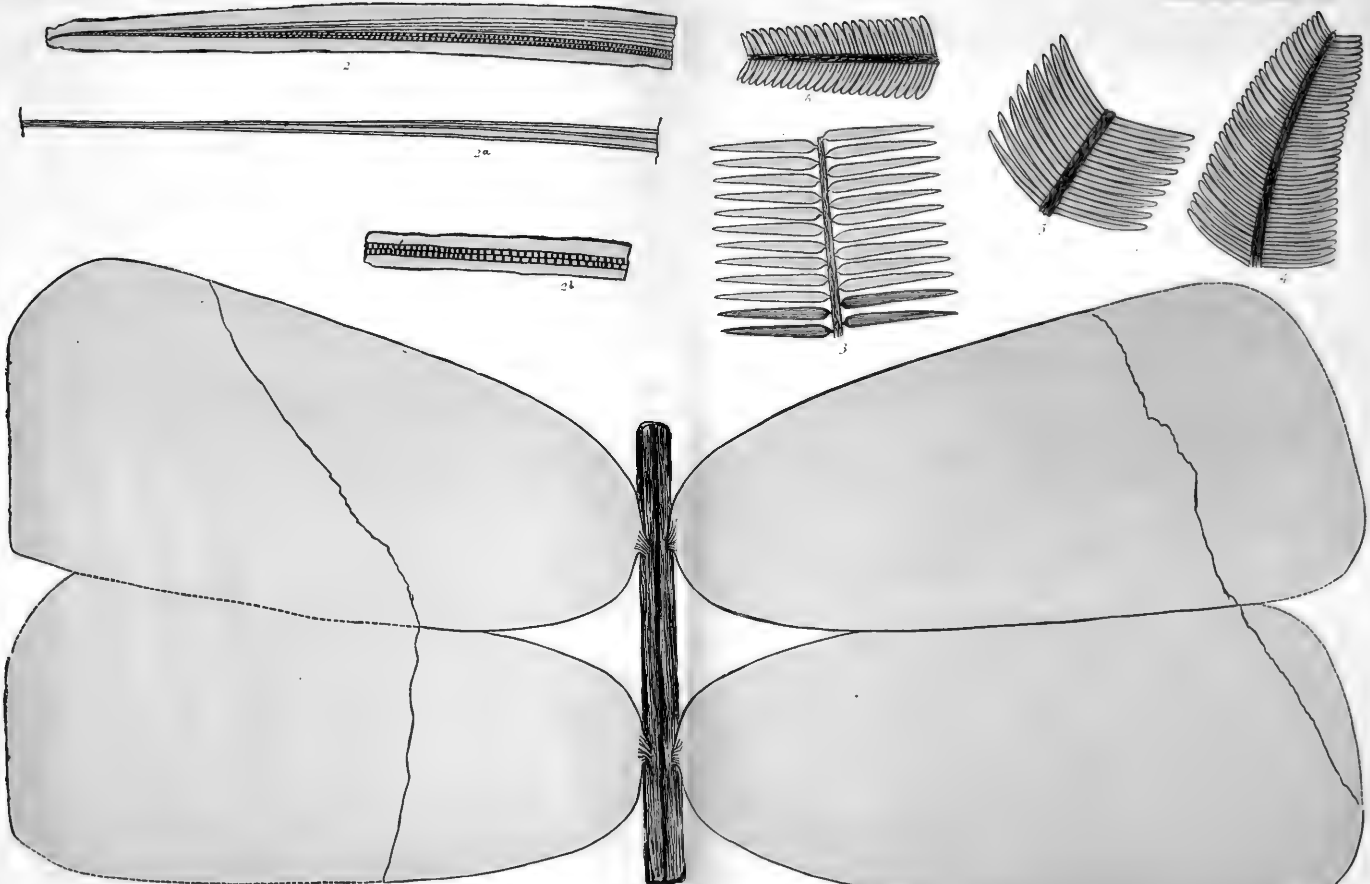

2
2a
2b
6
3
5
4
1

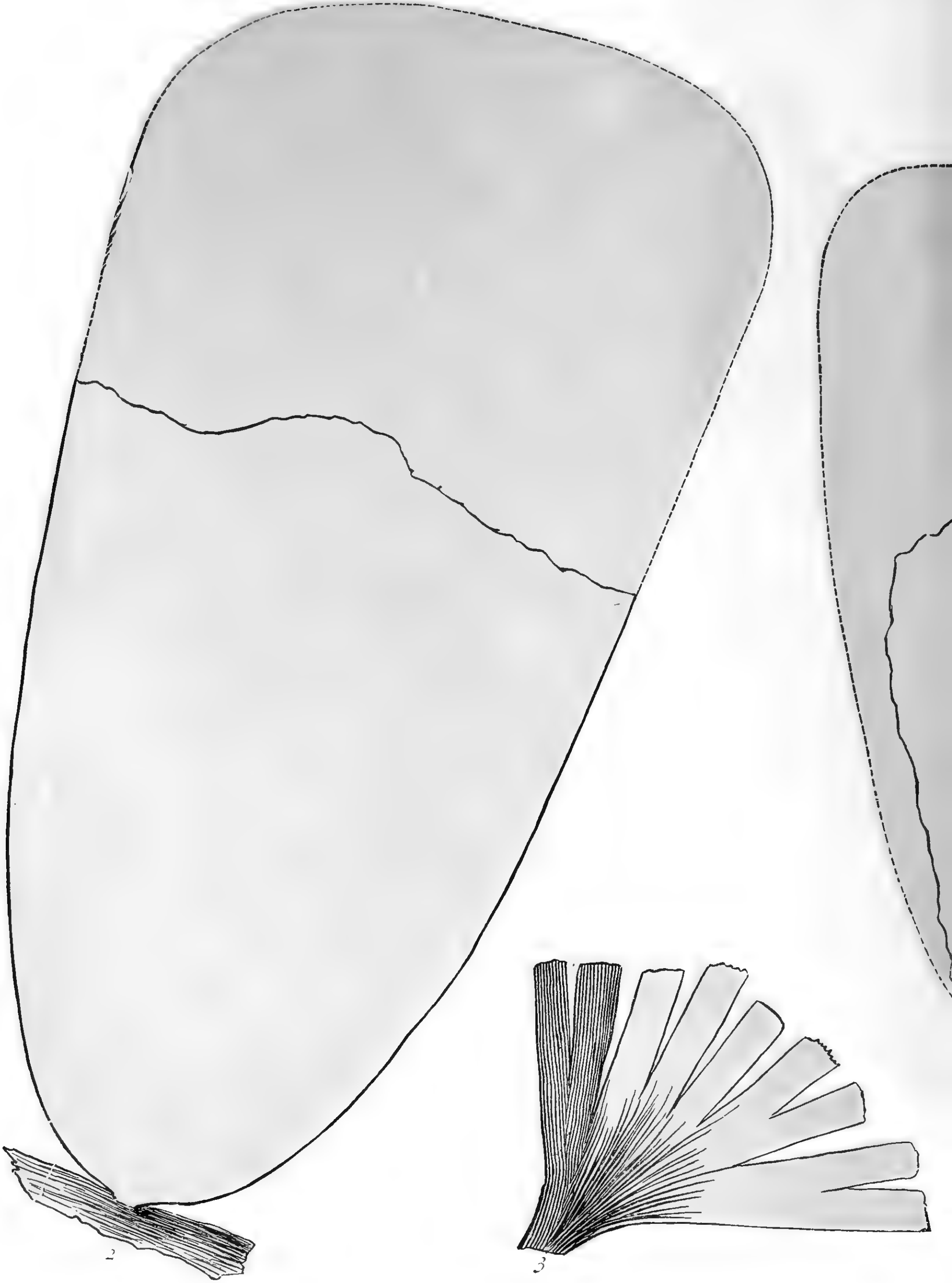
PLATE XLV (double).

FIGS. 1, 2. *Sphenozamites Rogersianus*, spec. nov. Pages 80 to 84.

FIG. 1. Represents the summit of a leaf of normal size.

FIG. 2. Represents a leaflet of the largest size.

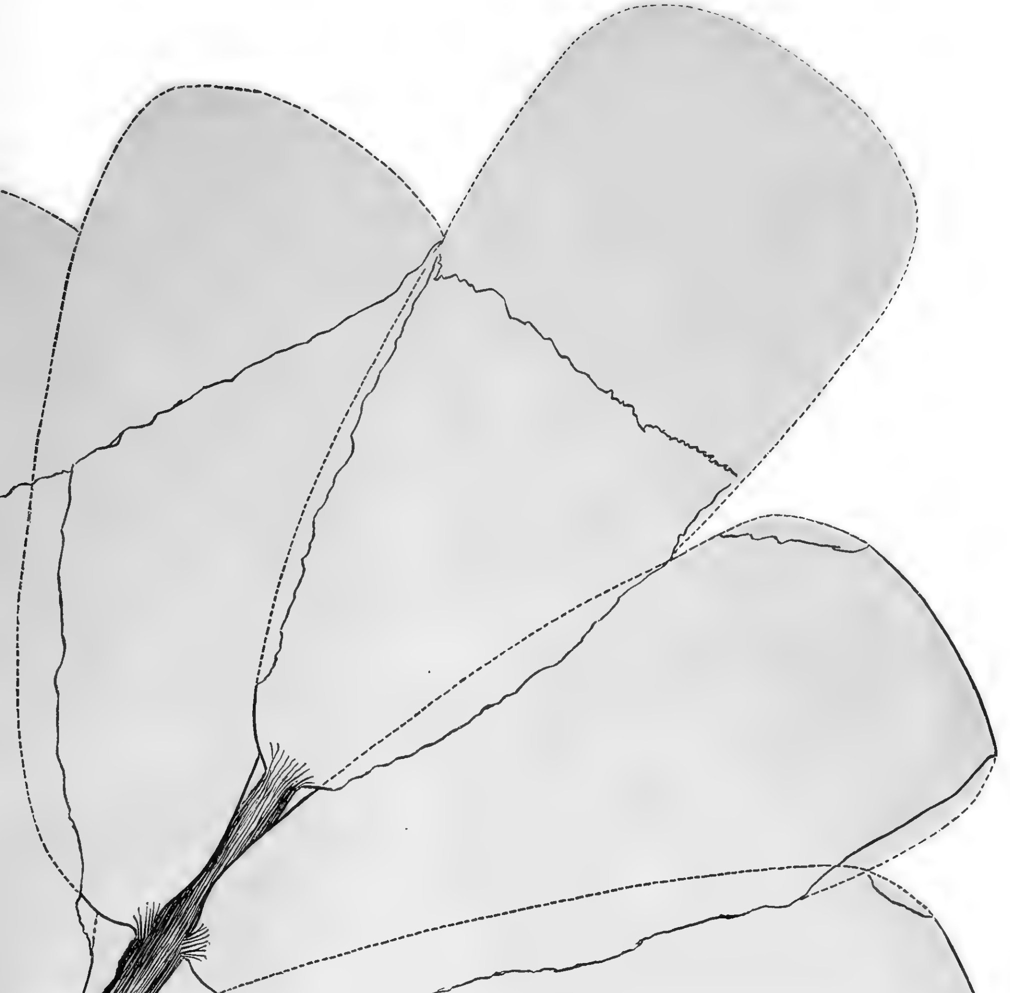
FIG. 3. *Baiera multifida*, spec. nov. Pages 87 to 88. Basal portion of a leaf.



2

3

SPHENO



ES—BAIERA

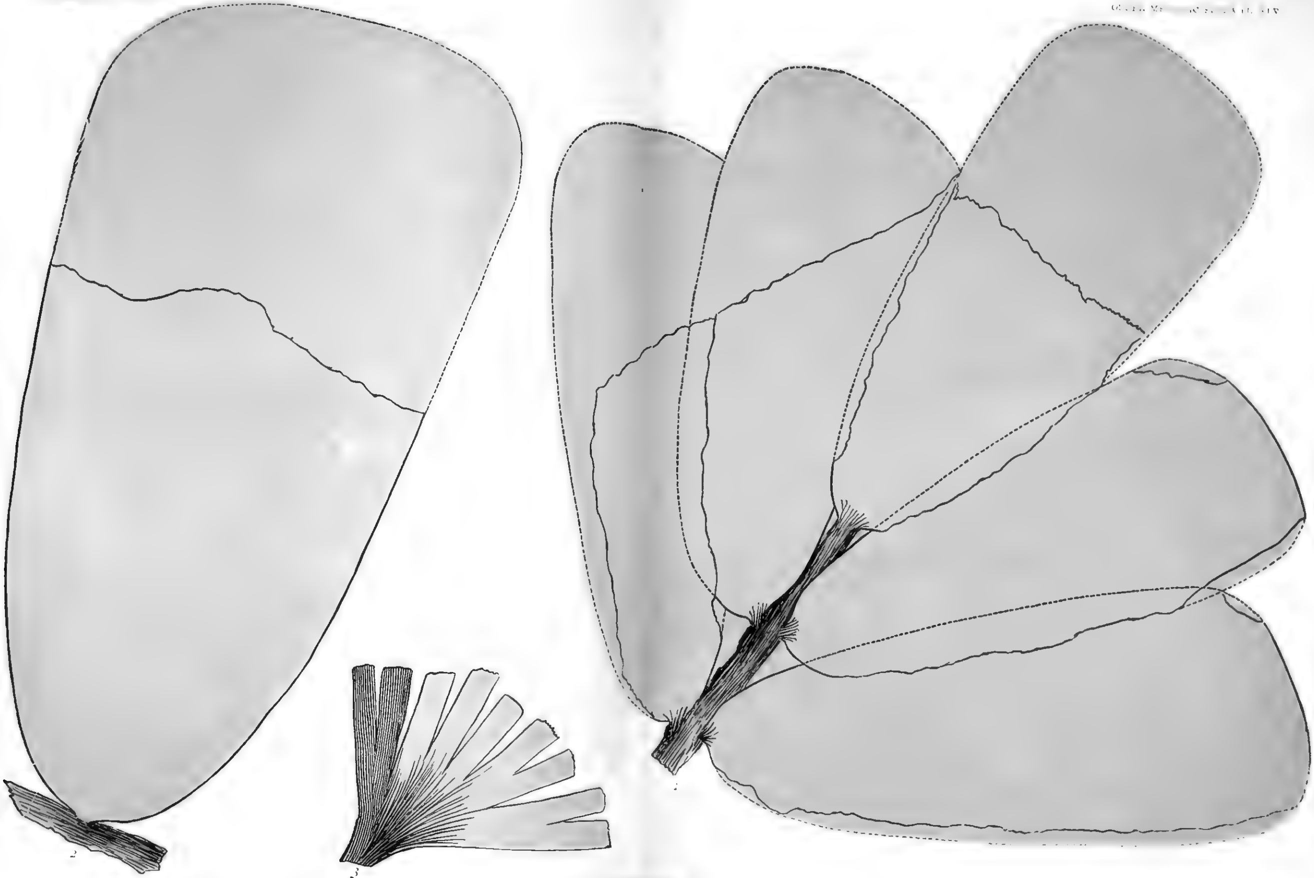

2
3

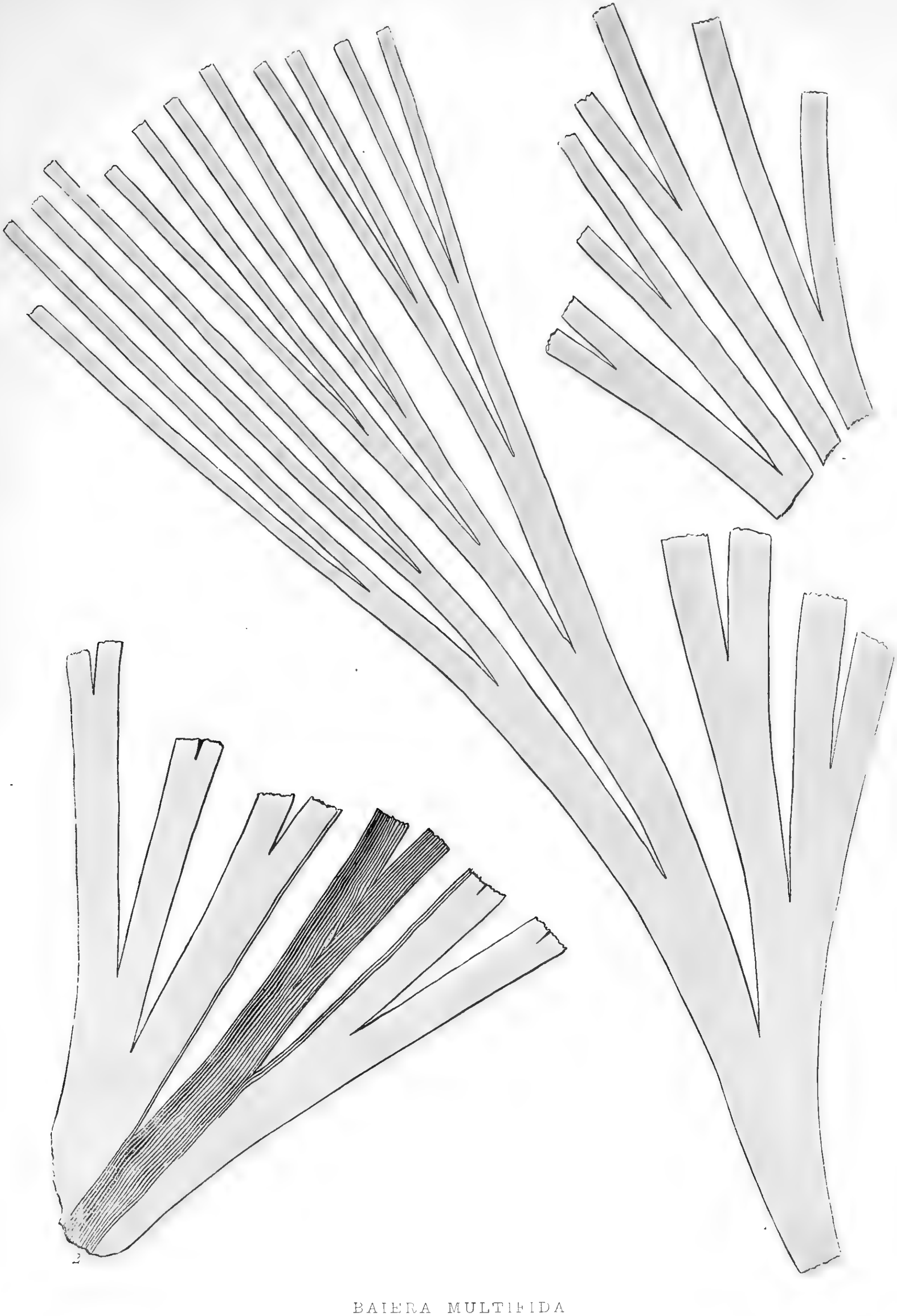
PLATE XLVI.

FIGS. 1–3. *Baiera multifida*, spec nov. Pages 87 to 88.

FIG. 1. Portion of a leaf showing the numerous subdivisions towards the summit of the leaf.

FIG. 2. Portion of the lower part of a leaf showing nervation.

FIG. 3. Fragment of the upper part of a leaf.



BAIERA MULTIFIDA

PLATE XLVII.

FIGS. 1, 2. *Baiera multifida*, spec. nov. Pages 87 to 88.

FIG. 1. Segment of a much-divided leaf.

FIG. 2. Fragment of a very large leaf showing nervation.

FIG. 3. Cone of conifer, spec. ? Page 91.

FIGS. 4–5 *a*. *Zamiostrobus Virginiensis*, spec. nov. Page 85.

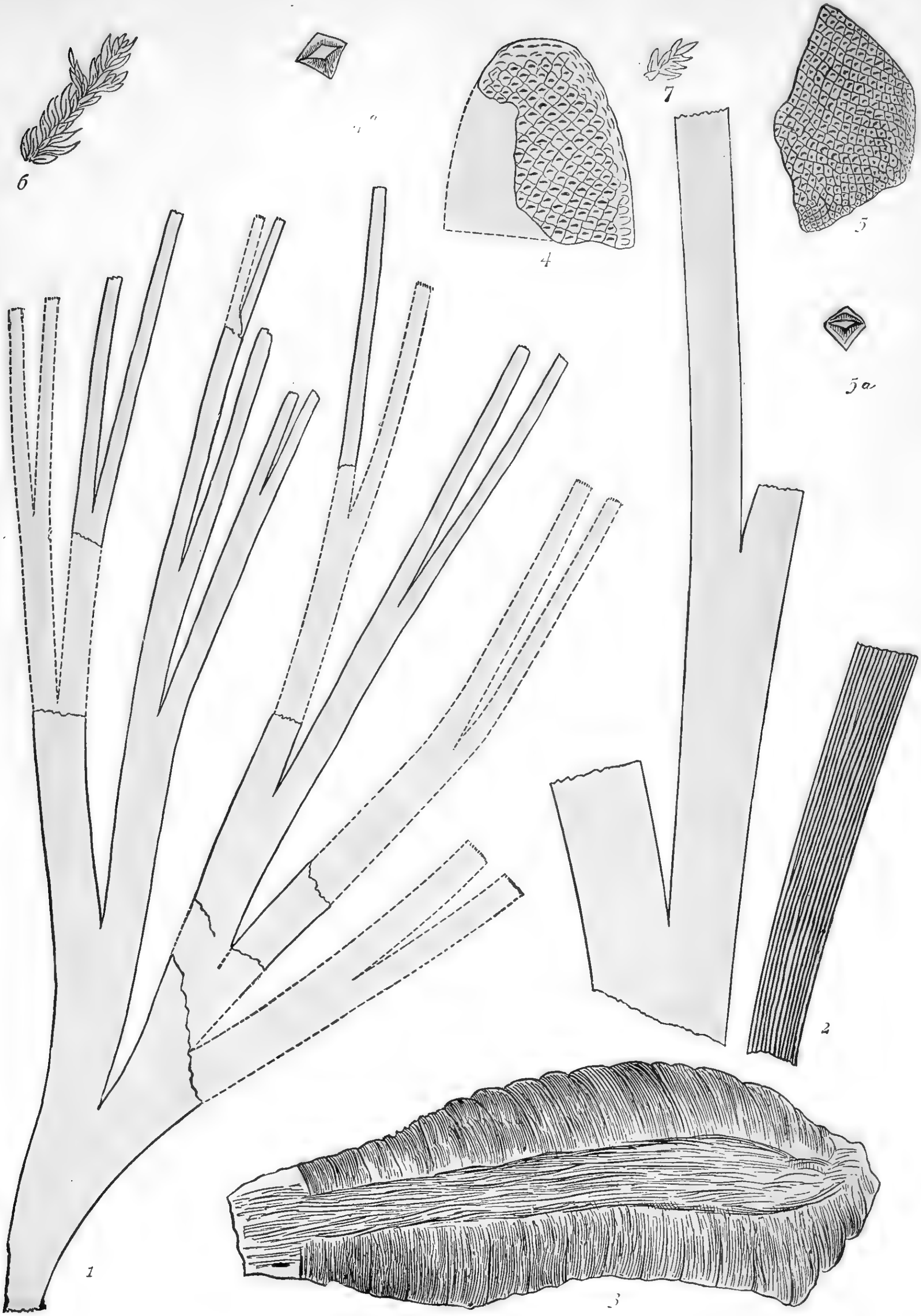
FIGS. 4, 5. Represent fragments of different cones, showing somewhat different shapes inthe scars of the scales.

FIGS. 4 *a*, 5 *a*. Represent scars of Figs. 4 and 5 magnified to show shape.

FIGS. 6, 7. *Cheirolepis Münsteri* (Schenk), Schimper. Pages 88 to 89. Terminal portions of small twigs.

FIG. 6. Is a copy of Rogers's figure.

FIG. 7. Represents a small fragment found in the Cumberland area of the Mesozoic.



BAIERA—ZAMIOSTROBUS—CHEIROLEPIS

PLATE XLVIII.

FIG. 1. Cone of a conifer of the same species as that shown in Fig. 3, Plate XLVII. This shows what was probably the base of the cone. Page 91.

FIG. 2. Fragment of an undetermined plant. Page 90.

FIG. 3. Fragment of Bambusium? Page 90.

FIG. 3*a*. Represents a portion of Fig. 3, magnified to show the nervation.

FIG. 4. Fragment of an undetermined plant. Page 90.

FIG. 5. Impression of a portion of the stem of a cycad. Page 91.

FIG. 5*a*. Leaf-scar of Fig. 5 magnified.

FIGS. 6, 7. *Laccopteris Emmonsi* (Emmons). Page 101. Emmons, "Am. Geol.," plate 4, figs. 5 and 9.

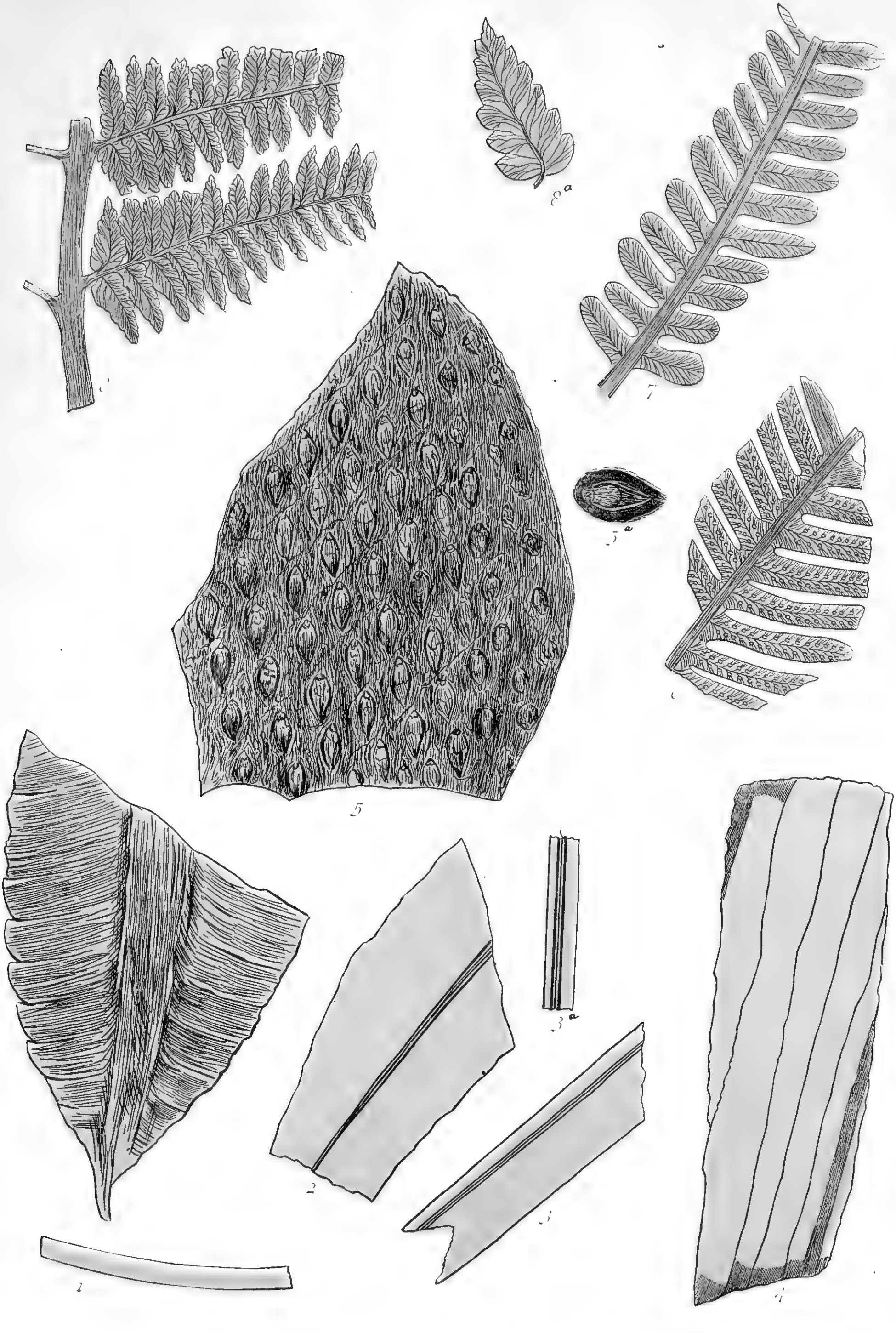
FIG. 6. Portion of a fertile pinna.

FIG. 7. Portion of a sterile pinna.

FIG. 8. *Acrostichides Egyptiacus*. Page 98. Emmons, "Am. Geol.," fig. 8.

FIG. 8*a*. Magnified pinnule, showing nervation.

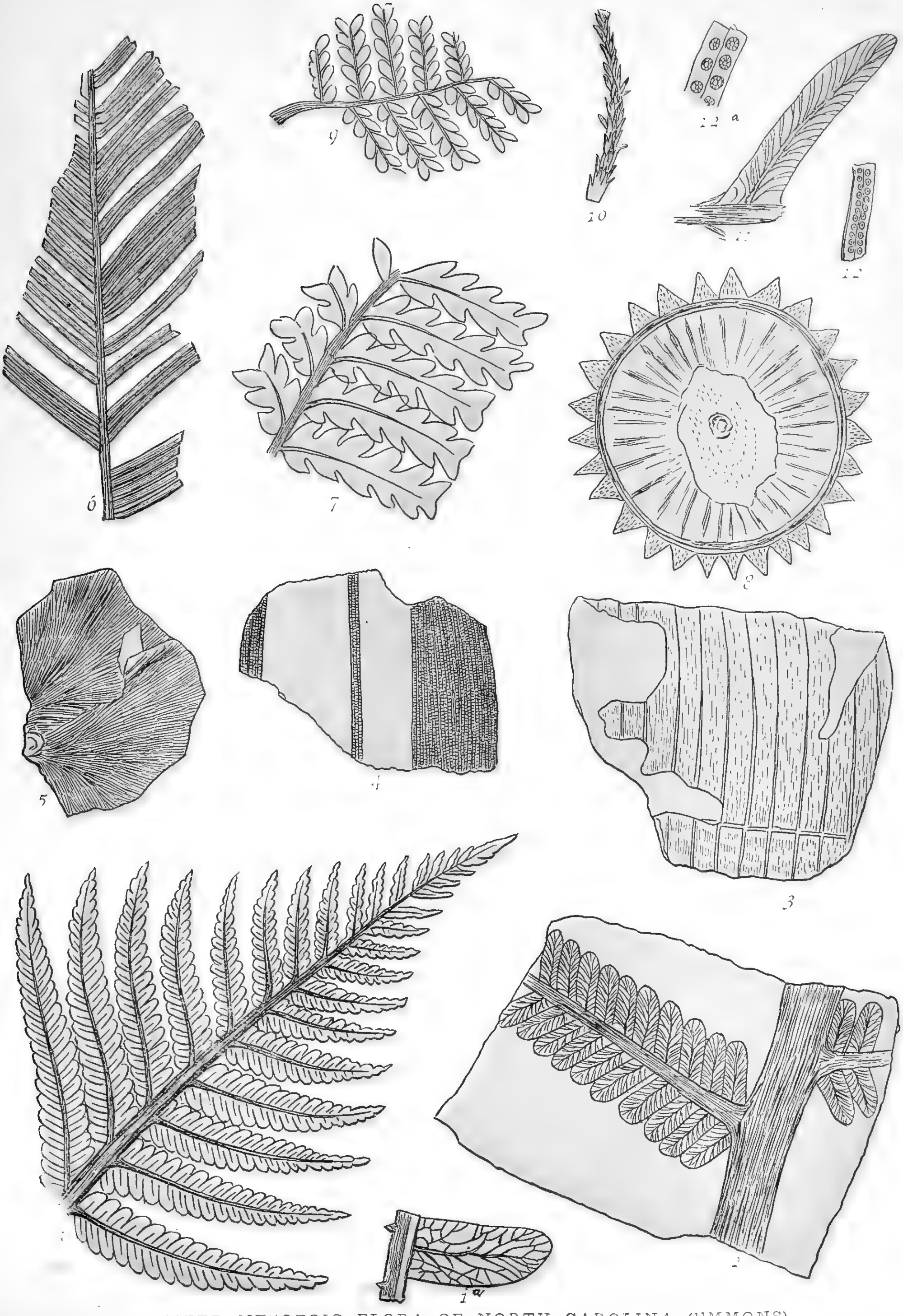
* The pages given as here for these North Carolina plants refer to pages of this work.



BAIERA—LACCOPTERIS—ACROSTICHIDES

PLATE XLIX.

FIGS. 1, 1*a*. *Lonchopteris oblongus*. Page 102. Emmons, "Am. Geol.," plate 4, figs. 6 and 8.
    FIG. 1. Summit of frond.
    FIG. 1*a*. Pinnule of Fig. 1, enlarged.
FIG. 2. *Asterocarpus platyrachis*. Page 103. Emmons "Am. Geol.," fig. 71.
FIG. 3. *Equisetum Rogersi*. Page 109. Emmons, "Am. Geol.," plate 6, fig. 3.
FIG. 4. *Sphenozamites Rogersianus*. Page 98. Emmons, "Am. Geol.," plate 6, fig. 5.
FIG. 5. *Sagenopteris rhoifolia*. Page 104. Emmons, "Am. Geol.," plate 4, fig. 10.
FIG. 6. *Ctenophyllum Braunianum*, Var. *a*. Page 114. Emmons, "Am. Geol.," plate 4, fig. 11.
FIG. 7. *Acrostichides rhombifolius*. Page 105. Emmons, "Am. Geol.," plate 3, fig. 5.
FIG. 8. *Araucarites Carolinensis*. Page 118. Emmons, "Am. Geol.," plate 3, fig. 4.
FIG. 9. *Cladophlebis obtusilobus*. Page 105. Emmons, "Am. Geol.," plate 6, fig. 1.
FIG. 10. *Cheirolepis Münsteri*. Page 98. Emmons, "Am. Geol.," plate 3, fig. 3.
FIGS. 11, 12, 12*a*. *Laccopteris Carolinensis*. Page 102. Emmons, "Am. Geol.," fig. 68 and plate 4, figs. 1, 2.
    FIG. 11. Sterile pinnules enlarged.
    FIG. 12. Portion of fertile pinnule.
    FIG. 12*a*. Portion of Fig. 12, magnified.



LOWER MESOZOIC FLORA OF NORTH CAROLINA (EMMONS)

PLATE L.

FIGS. 1, 2. *Palissya Braunii.* Page 106. Emmons, "Am. Geol."

FIG. 1. Portion of a large branch. Emmons, "Am. Geol.," plate 4*a*.

FIG. 2. Summit of branch with cone? Emmons, "Am. Geol.," fig. 72.

FIG. 3. *Cheirolepis Münsteri.* Page 107. Emmons, "Am. Geol.," fig. 75.

FIG. 4. *Pachyphyllum peregrinum.* Page 108. Emmons, "Am. Geol.," fig. 76.

LOW[illegible] FLO[illegible] NO[illegible] CAROLINA (EMMONS)

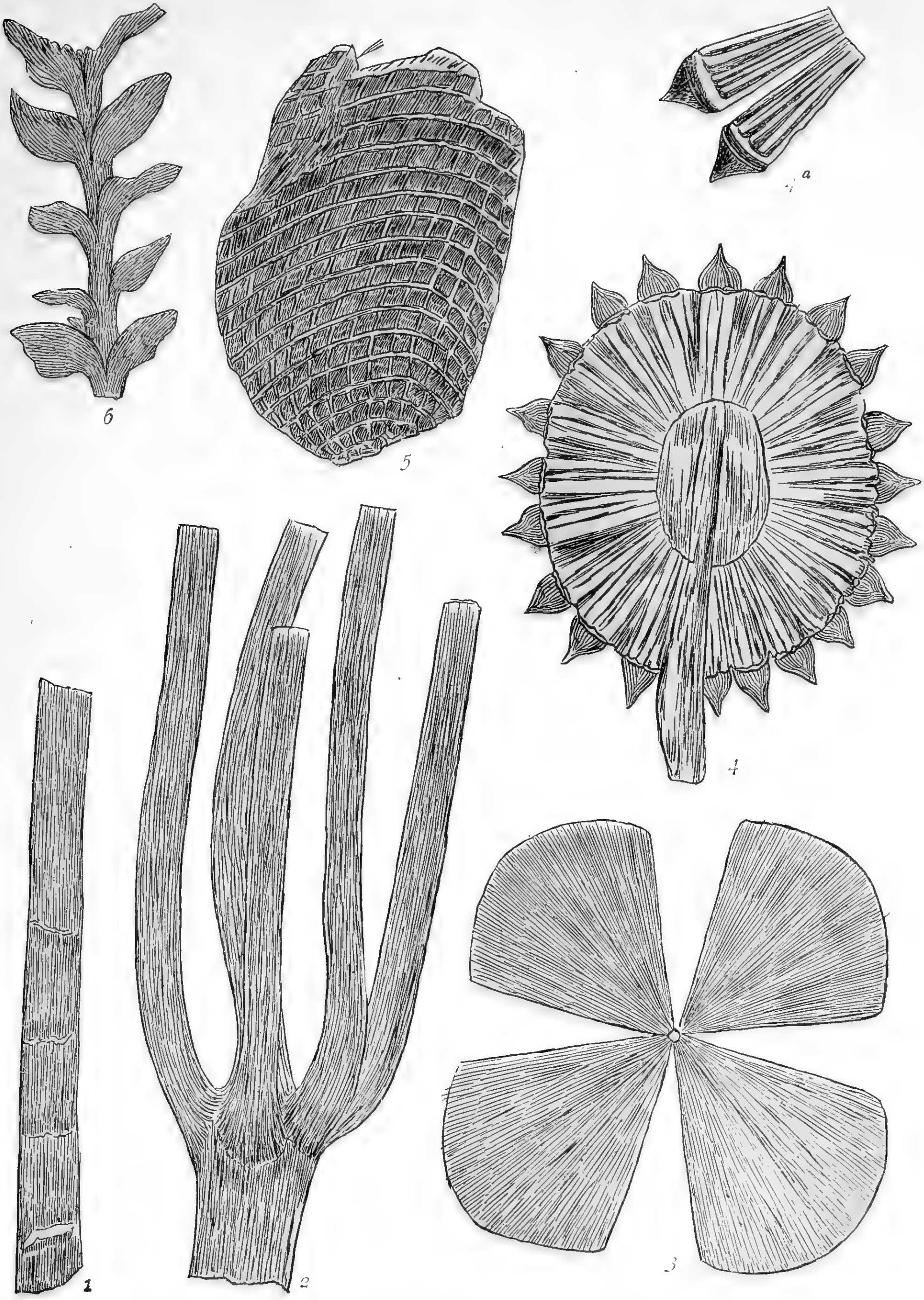
PLATE LI.

FIG. 1 *Palissya Braunii.* Page 106. Emmons, "Am. Geol.," fig. 73.
FIG. 2 *Pterophyllum decussatum.* Page 111. Emmons, "Am. Geol.," plate 3, fig. 1.
FIG. 3 *Cycadites acutus.* Page 109. Emmons, "Am. Geol.," fig. 81.
FIG. 4 *Palissya diffusa.* Page 106. Emmons, "Am. Geol.," plate 3, fig. 2.
FIG. 5 *Palissya Carolinensis.* Page 109. Emmons, "Am. Geol.," fig. 80.
FIG. 6 *Laccopteris elegans.* Page 104. Emmons, "Am. Geol.," plate 6, fig. 2.
FIG. 7 *Cycadites longifolius.* Page 110. Emmons, "Am. Geol.," fig. 82.
FIG. 8 *Baiera Münsteriana.* Page 120. Emmons, "Am. Geol.," fig. 102.

LOWER MESOZOIC FLORA OF NORTH CAROLINA (EMMONS)

PLATE LII.

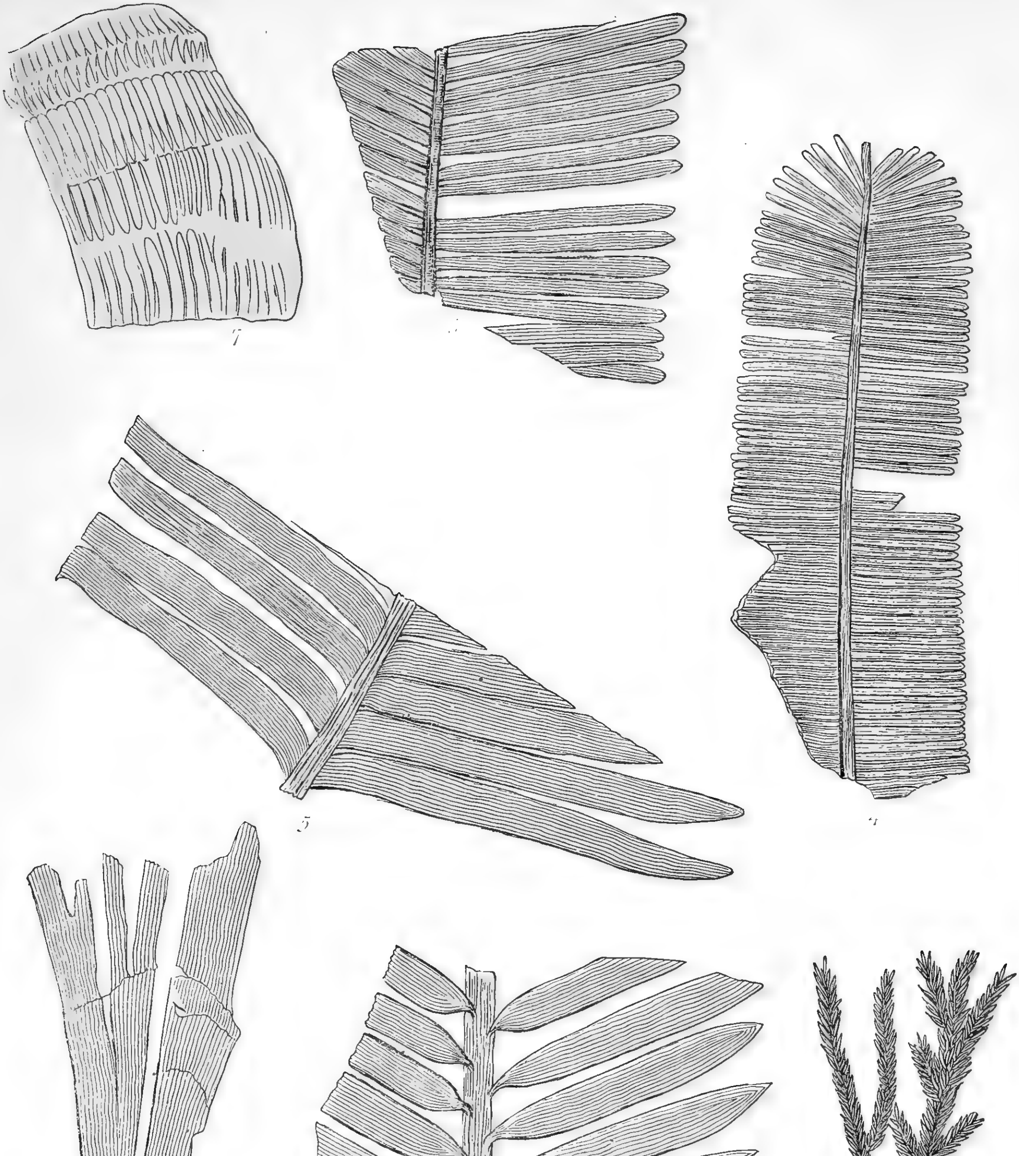
FIG. 1. *Bambusium ? Carolinense.* Page 120. Emmons, "Am. Geol.," fig. 100.
FIG. 2. Undetermined plant. Page 119. Emmons, "Am. Geol.," fig. 99.
FIG. 3. *Actinopteris quadrifoliata.* Page 119. Emmons, "Am. Geol.," plate 6, fig. 2.
FIG. 4. *Araucarites Carolinensis.* Page 118. Emmons, "Am. Geol.," fig. 98.
FIG. 4 *a.* Scales of the cone magnified. Emmons, "Am. Geol.," plate 3, fig. 6.
FIG. 5. *Zamiostrobus Emmonsi.* Page 117. Emmons, "Am. Geol.," fig. 92 *a.*
FIG. 6. *Otozamites Carolinensis.* Page 117. Emmons, "Am. Geol.," fig. 95.



LOWER MESOZOIC FLORA OF NORTH CAROLINA (EMMONS)

PLATE LIII.

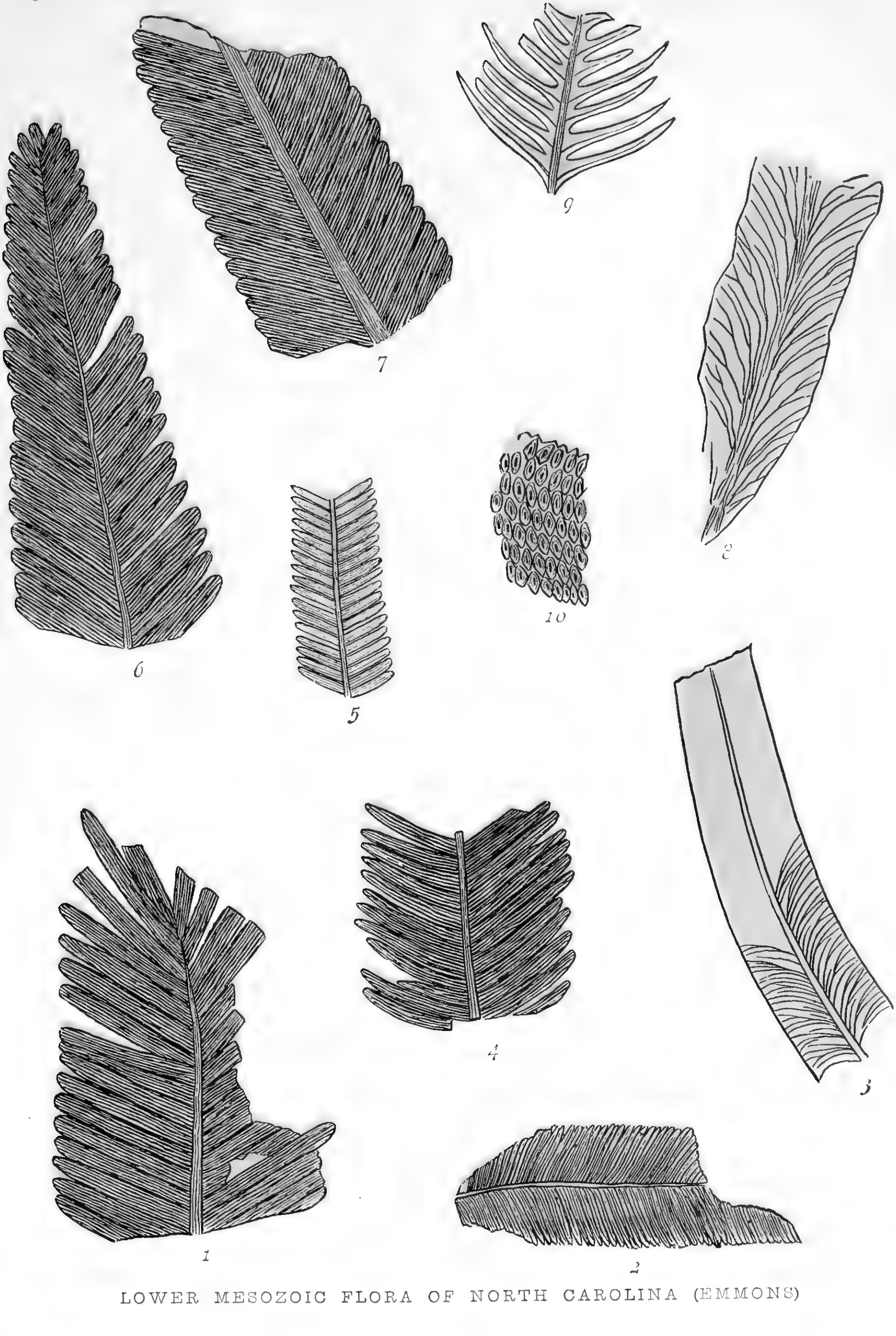
FIG. 1. *Baiera multifida.* Page 118. Emmons, "Am. Geol.," fig. 96.
FIG. 2. *Podozamites Emmonsi.* Page 110. Emmons, "Am. Geol.," plate 3, fig. 7.
FIG. 3. *Cheirolepis Münsteri.* Page 107. Emmons, "Am. Geol.," fig. 74.
FIG. 4. *Pterophyllum pectinatum.* Page —. Emmons, "Am. Geol.," fig. 84.
FIG. 5. *Dioonites longifolius.* Page 110. Emmons, "Am. Geol.," fig. 83.
FIG. 6. *Pterophyllum spatulatum.* Page 114. Emmons, "Am. Geol.," fig. 88.
FIG. 7. *Equisetum Rogersi.* Page 108. Emmons, "Am. Geol.," plate 6, fig. 9.



LOWER MESOZOIC FLORA OF NORTH CAROLINA (EMMONS)

PLATE LIV.

FIG. 1. *Ctenophyllum Emmonsi.* Page 113. Emmons, "Am. Geol.," fig. 86*a*.
FIG. 2. *Ctenophyllum lineare.* Page 113. Emmons, "Am. Geol.," fig. 87.
FIG. 3. *Pseudodanæopsis reticulata.* Page 116. Emmons, "Am. Geol.," fig. 90.
FIGS. 4, 5. *Ctenophyllum Braunianum* var. *β*. Page 112. Emmons, "Am." Geol.
  FIG. 4. Portion of plant of normal size. Emmons, "Am. Geol.," fig. 85.
  FIG. 5. Portion of a plant of the smaller kind. Emmons, "Am. Geol.," fig. 86.
FIGS. 6, 7. *Ctenophyllum robustum.* Page 116. Emmons, "Am. Geol."
  FIG. 6. Summit of leaf. Emmons, "Am. Geol.," fig. 92.
  FIG. 7. Middle portion of a leaf. Emmons, "Am. Geol.," fig. 91.
FIG. 8. *Pseudodanæopsis nervosa.* Page 115. Emmons, "Am. Geol.," fig. 89.
FIG. 9. *Asplenites Rösserti.* Page 104. Emmons, "Am. Geol.," plate 4, fig. 3.
FIG. 10. *Zamiostrobus* spec.? Page 117. Emmons, "Am. Geol.," fig. 93.



LOWER MESOZOIC FLORA OF NORTH CAROLINA (EMMONS)